FRIDAY, MARCH 2, 1883.

## THE INTERNATIONAL CONFERENCE FOR THE DETERMINATION OF THE ELECTRICAL UNITS.

At a meeting of the electrical congress, Oct. 5, 1881, it was recommended that the French government should invite the other powers to constitute an international commission to discuss the following points: —

1. To determine for practical science the conditions which a column of mercury should fulfil in order to represent the electrical unit of resistance.

2. To determine upon a definite standard of light.

3. To arrange a systematic and universal plan for studying atmospheric electricity, terrestrial magnetism, and the exchange of international observations.

In accordance with this recommendation the French government communicated with the other powers; and representatives appointed by the various governments assembled in Paris, Oct. 16, 1882, at the residence of the foreign minister. At the first meeting there were forty-seven representatives present, among whom were Helmholtz, W. Siemens, Wiedemann, Kohlrausch, Fröhlich, Lorenz, Dumas, Mascart, Tacchini, and Weber. The representatives from Great Britain and the United States had not been notified in time to attend the opening of the conference.

Upon organization, three committees were formed, — one upon electrical units, one upon earth-currents and lightning-rods, and another upon a standard of light. At first the time of the conference was largely devoted to discussions of the best methods of determining the unit of electrical resistance. Various suggestions were made in regard to the limits of accuracy, and to the necessity of repeating the observations already made at different places on the earth's surface, in order to eliminate the errors due to locality. M. Broch of Norway suggested that the calorimetric determinations of the ohm should be carefully made; this method being the most direct one, although it required a precise value of the mechanical equivalent of heat. Sir W. Thomson and Helmholtz pointed out that the heat method depended upon the measurement of current, and could only be considered as a method of control. MM. Lorenz and Roiti presented papers upon the determination of the ohm, and Wiedemann gave a bibliography of the subject. After hearing the careful and minute discussion of the subject, the following resolutions were adopted: —

1. The commission consider that the determinations made up to the present time are not sufficiently concordant to allow the value of the ohm to be fixed.

They believe that it is necessary to continue the researches upon this value. Although they do not advise observers to restrict themselves in the choice of methods, they consider the following methods particularly adapted for exact determinations: —

*a*. Induction of a current upon a closed circuit (Kirchoff).

*b*. Induction by the earth (W. Weber).

*c*. Decrement of moving magnets (W. Weber).

*d*. Apparatus of the British association.

*e*. Methods of M. Lorenz.

It is also desirable to determine the ohm by the quantity of heat evolved by a given current, using this method as a control method.

2. It is thought desirable that the French government should take the necessary steps to prepare certain standards of resistance, which can be placed at the disposal of scientific men, in order to compare their values.

The commission was, at first, of the opinion, that when the results of the different observers reach an approximation of $\frac{1}{1000}$ of the true value, the value of the practical unit of resistance should then be fixed. After much discussion, it was felt that no decision upon the limit of accuracy could be reached at present. Mascart then described the methods adopted for the study of atmospheric electricity. Sir W. Thomson showed that it was important to make observations upon the air in a definite enclosure, or, in other words, upon the air itself. Helmholtz in this connection remarked,

that one of his students had shown that the electrification of the air in the interior of a laboratory could be readily perceived. Thomson then gave a short description of the kind of room and the disposition of its walls which would be desirable in an observatory for such researches. The commission concluded to recommend to the various governments regular observations on atmospheric electricity.

An interesting discussion upon lightning-rods then followed. Helmholtz said, that statistics in regard to strokes of lightning and in regard to the effect of various kinds of lightning-rods were about to be collected in the province of Schleswig-Holstein, the position of this province between two seas being particularly advantageous. It already had appeared that the country is more exposed to strokes of lightning than the cities, and that in villages the public buildings were more frequently struck than the houses. He also remarked, that the academy of Berlin had recommended the employment on telephone-lines, where they enter houses, of a lightning-protector, consisting of two little spheres very near each other, one of which is connected to the line, and the other to the earth. M. Ludewig of Germany gave some statistics in regard to damage to telegraphic and telephonic apparatus in Germany during the period from April 1, 1881, to Aug. 20, 1881. During this time there had been 2,301 storms; and these had produced 2,165 cases of damage, more or less serious.

It was debated whether a set of questions in regard to the perturbing effect of storms upon telegraphic apparatus should be issued. After much discussion, a sub-committee was formed to formulate a set of questions. Among the members of this committee were Helmholtz and Mascart. The question of the observation of earth-currents was then taken up. It was regretted that the existing telegraph-lines running north and south, and east and west, could not be utilized for the observation of earth-currents. The pressure of business usually prevented this. M. Blavier pointed out, that the earth-currents are generally too feeble to be observed on telegraph-lines which are in operation. Moreover, the polarization of the earth-plates of the battery would cause trouble. Mascart, in reply, said that he had noticed that the maximum disturbance was reached slowly, through a period of several days, and died out also slowly. He therefore thought that existing telegraphic lines could be used, notwithstanding the objections of M. Blavier. He proposed that observations should be made upon lines reserved for the purpose, and also on existing telegraphic systems. A question arose upon the length that these lines should have. Helmholtz remarked, that one could make observations on lines from one to two kilometres in length. It would be necessary, however, to shun the effects of polarization of the electrodes. He thought that special plates surrounded by peroxide of manganese might be serviceable.

The commission in general were in accord on the necessity of organizing a systematic study of earth-currents upon telegraphic lines, or at least records of these currents on the days specified for observations by the international polar expeditions (the first and fifteenth of each month, from September, 1882, to September, 1883). In a general discussion which followed, upon lightning-conductors and electrical storms, Helmholtz expressed his doubt about the efficacy of extent of contact of lightning-conductors with the earth, and the varied nature of the plates employed. M. Van der Mensbrugghe (Belgium) spoke of the desirability of studying the nature of lightning discharges, especially that termed ball-lightning. Mascart replied, that he did not believe that cases of ball or globular lightning were well substantiated. It might happen that it was an illusion of the senses, and could therefore be relegated to physiology rather than to physics. The commission then discussed the question of studying the best conditions for the establishment of an international telemeteorographic system, which would permit various stations in different countries to communicate continuously with each other. They decided that it did not appear that the time had come for the establishment of such a system; but they ex-

pressed the opinion that such a system would be highly desirable.

Then followed a long discussion upon the standard of light. It was generally granted that a white light was desirable. Wiedemann remarked, that a fine gauze saturated with the spirit of turpentine, burning in oxygen, gave a very white light. Siemens proposed to employ a current of oxygen passing through a carburetted hydrogen, maintained at some fixed temperature. One could thus obtain a constant mixture which would burn with a white flame. Helmholtz thought that it would be extremely difficult to produce a mixture of air and carburetted hydrogen in constant proportion, and to regulate the temperature. Dumas thought that the late experiments of Violle upon the light emitted by melting platinum might solve the problem. The point of fusion of a body seemed to him to be as good a fixed point as could be wished. He invited the commission to view the experiments of Violle.

After witnessing the experiments of Violle, the members of the commission appeared to think more favorably of Dumas' suggestion. Professor Leblanc, who has had charge for many years of the photometric determinations of the lighting-gas of Paris, was invited to explain his methods; and the members of the commission, in turn, were invited to witness the methods in his laboratory. Professor Leblanc stated his preferences for the employment of a Carcel lamp for photometric determinations. He showed that the personal equation could be practically eliminated, and that differences of tint did not influence the results to the degree supposed. Sir W. Thomson spoke of the advantages of Rumford's photometer. The following resolutions upon this subject were finally adopted: —

*a.* The conference express their hope that the experiments now in process upon the light emitted by melting platinum will lead to a definite standard of light.

*b.* They recommend the employment of the Carcel lamp as a secondary standard, this lamp to be employed with the precautions adopted by MM. Dumas and Regnault.

Candles can also be employed as a secondary standard, if sufficient care be taken in regard to their construction and constitution.

*c.* They call attention also to the necessity of the analysis of the different conditions under which comparisons of light are made, and reiterate the opinions, expressed at the meeting of the electrical congress of 1881, in regard to the necessity of taking into account the amount of light radiated from sources of light in different directions.

At the close of the conference, Sir W. Thomson expressed the opinion that the labors of the conference would stimulate researches during the coming year; and he congratulated the conference upon its important work.

On the 26th of October, President Grévy received the members of the commission at the Palais d'Elysées; and, after a reception by Minister Cochéry, on the afternoon of the same day, the conference was adjourned to the first Monday of October, 1883.

## *ON THE PHYSICAL CONDITIONS UNDER WHICH COAL WAS FORMED.*[1]

THE mode of formation of coal has been much discussed, and various theories have been promulgated in regard to it; but the peat-bog theory, as it is called, has been generally accepted. This is the view, that coal is the residual hydrocarbon of plants which have grown where their remains are found, and that it has been formed precisely as peat accumulates in marshes at the present day.

So great has been the harmony of opinion on this subject, that it would at first sight appear unnecessary to renew discussion on a question that had seemed to be definitely and permanently settled. The calm of geological opinion which has prevailed on the coal-question has, however, been recently disturbed by a very voluminous and painstaking discussion of the mode of formation of coal, by M. Grand'Eury, which occupies nearly 300 pages in the *Annales des mines* for the present year. In this discussion the theory is advocated, that the carbonaceous matter forming beds of coal has been derived from plants, but plants transported from their places of growth, and deposited at a greater or less distance in the bottom of water basins.

[1] Read before the National academy of sciences at its semi-annual meeting in New York, Nov. 14-17, 1882.

We have reports, also, from time to time, of a system of experiments and observations made by M. Fayol, at Commentry, in the department D'Alliers, in Central France, from which he draws the same inference; and it is apparent that a formidable attack has been made all along the line upon the peat-bog theory.

For this reason, and in order that geological truth shall be maintained, I venture to report some facts which I have myself observed in the coal-fields of the Mississippi valley, and which in my judgment are incompatible with the conclusions of MM. Grand'Eury and Fayol.

The opinions presented in the discussions of the chemical and physical history of coal have been based upon two classes of facts: viz., 1°, those gathered from the study *in the field* of the structure and relations of the coal-beds; and, 2°, those obtained from chemical and physical experiments conducted *in the laboratory*. Now, while there is no doubt that such experiments have contributed much to our understanding of the subject, it is obvious that they have misled observers, through the impossibility of imitating by artificial means the grand processes of nature. She has in most instances left a full and faithful record of her work; but the same difficulties attend the disinterment and translation of this buried record that have been encountered by the students of archeology in their efforts to trace the early history of mankind. Necessarily this is a work of time; and much study is required for the acquisition of a full and accurate knowledge of the language in which it is written, and for the gradual accumulation of the large amount of material required. Yet I claim, that so much of nature's record of the processes pursued in the formation of coal has been submitted to our observation, and that this record is so clear that the truth is within our reach; and, further, that this truth is discordant with the results obtained in artificial experimentation, and therefore proves such results fallacious.

In the present communication, nothing like a full discussion of the arguments *pro* and *con* will be attempted; since the space at my command will permit me to cite only a few of many facts, and to very briefly read their meaning.

For the present I will confine myself to some of the phenomena presented by one of the Ohio coal-beds with which I am specially familiar. This is our 'Coal No. 1,' the lowest of the series, sometimes called the Brier-Hill coal. As this has furnished a fuel of exceptional purity, such as could be used in the raw state for the smelting of iron, and lies nearer to the navigable waters of Lake Erie than any other, it has been very extensively worked. The result of this working has been to show, that the coal is confined to a small part of the area it was once supposed to cover, and that it lies in a series of narrow troughs, or basins, which were evidently once peat-marshes, occupying local depressions in the then existing surface. A large number of these detached coal-deposits have been now completely worked out, and the phenomena they present fully exposed to view. Among these phenomena I may cite: —

1. Below the coal a fire-clay, penetrated in every direction with roots and rootlets of Lepidodendron, Sigillaria, etc.

2. A coal-seam having a maximum thickness of six feet in the bottom of the basins, thinning out to feather-edges on the sides, and containing only two to three per cent of ash.

3. The coal on the margins of a basin rising sometimes thirty or forty feet above its place on the bottom.

4. A roof composed of argillaceous shale, of which the lower layers, a few inches in thickness, are crowded with the impressions of plants; among which are interlocked prostrate trunks of Lepidodendra and Sigillaria, traceable from root to summit, often carrying foliage and fruit, the fronds of ferns, — sometimes ten or fifteen feet in length, complete and smoothly spread, — Calamites, Cordaites, etc.

5. In many places the roof marked with circles one to two feet in diameter, called by the miners 'pot-bottoms.' These are sections of the bases of the upright trunks of Sigillaria or Lepidodendron, which rise *perpendicularly*, sometimes many feet, into the overlying shales. They consist of hollow cylinders of coal, perhaps a half-inch in thickness, the interiors of which are filled in with shale, laminated horizontally, and sometimes contain remains of plants and animals which must have been introduced when they were hollow stumps standing where they grew.

6. In certain circumscribed areas, part of the coal-seam is cannel, bituminous shale, or black-band iron-ore; and, as in all cases of this kind, the cannel, shale, and black-band contain the remains of aquatic animals, — crustacea, fishes, or mollusks, — the normal or cubical coal never including any thing of the kind.

7. The boundaries and bottoms of the chan-

nels and basins which hold the coal, composed of the Waverley shales, or the carboniferous conglomerate.

From these facts I translate the following history, which I am sure will be accepted as true by every geologist who has had sufficient experience in field-work to make his judgment of such phenomena trustworthy.

I. At the beginning of the formation of the coal-measures, north-eastern Ohio was a land surface, underlain by the Waverley shales, or beds of gravel, now the conglomerate. This surface was furrowed by the valleys of streams, and pitted by local basins, similar to those which mark the present surface.

II. With a slow subsidence, which continued with interruptions throughout the coal-measure epoch, the drainage was checked, and lakes and marshes were formed in the depressions of the surface. In these basins a fine sediment was deposited, — the 'fire-clay,' — like the clay now found under some of our peat-beds. When overgrown with vegetation the roots of plants penetrating this silt drew out of it iron, potash, soda, etc., leaving it nearly pure silicate of alumina, and specially refractory; whence its uses and name.

III. The marshes and lakes were ultimately filled with peat, which rose to a general level near the water-line, and was sometimes thirty or forty feet deep in the deepest parts of the basins.

IV. In places, water-basins remained such through a considerable portion of the time occupied in the accumulation of the peat; and sluggish streams flowed through the marshes, connecting these basins, and transporting to them fine sand, clay, lime, iron, etc., which, mingling with the completely macerated vegetable tissue, formed cannel coal, black-band iron-ore, and bituminous shale. After a time these basins also were filled with peat growing from the margins, just as our lakelets are now filled, and converted into peat-marshes.

V. After ages had passed with the physical conditions described, a subsidence caused a submergence of the peat-marshes, which first resulted in the destruction of the generation of growing plants that covered them. These dropped, in succession, leaves, twigs, and branches; and, finally, most of the standing trees fell. Some, however, continued longer to maintain an upright position, while the fine argillaceous sediment suspended in the water was slowly deposited around them, to form the roof shale, — of which the lower layers are charged with the *débris* of the plants growing on the marsh; the upper layers, deposited when these were all buried, nearly barren of fossils.

VI. The weight of the superincumbent mass pressed down the bed of peat; which, consolidated by that process, and undergoing internal chemical changes, ultimately became a bed of coal, thickest in the deepest part of each basin, thinning and rising on each side up to its edge, which remains to mark the original level of the surface of the peat-marsh.

Thus, and in no other conceivable way, was the resulting coal-bed made six feet thick in the bottom of the basin, and running out to nothing on the sides, thirty or forty feet higher.

The whole anatomy of the coal-seam shows that it was formed where it is found; the erect trees and plant-bearing shale above, the root-penetrated fire-clay below, the small amount of ash (only the inorganic matter of the plants), with many other features it presents, making the theory that it has been transported untenable. J. S. NEWBERRY.

## *THE YALE OBSERVATORY HELIOMETER.*

FOR the benefit of the non-astronomical reader whose heliometric ideas are vague, the instrument may be defined as a measuring-machine in which the images of two stars, or other celestial objects to be measured, are superposed in the telescopic field by the following method: a telescope object-glass is cut across one of its diameters, and the two halves thus formed can be moved in opposite directions along the line of section by the observer while looking through the eye-piece. If he were examining the sun, for instance, with the two halves of the object-glass together, then he would have an ordinary telescopic view of the sun; but let him separate them, and he has the effect produced in the sextant when the two sun's images are separated by moving the arm. Now, if he brings the two images tangent first on one side and then on the opposite side by passing one over the other, the distance the object-glass halves are moved can evidently be expressed in arc, when the focal length is known, and is a measure of the sun's angular diameter. The advantages of such a method of measurement are only to be fully appreciated from certain considerations in physiological optics, from which it seems to be established that the most accurate measurements by direct vision are to be expected when the measuring-scale and the object measured are precisely similar in appearance and

can be symmetrically placed. In the case given, the sun's limbs are of the same color and form, and the two positions are symmetrical with reference to each other. In measuring stars, the apparent magnitudes being made approximately equal, their images may be made to pass over each other with the greatest nicety; and in both these cases the observer's eye is steadily directed to a definite point in the telescopic field. In practice this seems to give more precise results than when the observer's attention is directed to two points at some distance from each other, and both bisected by the webs of the ordinary micrometer. In the telescope, with such a micrometer, the most exact measurements are not often extended over a minute of arc. And this limit is fixed by the field of view, which decreases as the magnifying power increases. With the heliometer, however, the limit of the distance which can be measured is independent of the magnifying power and the field of view, but is limited by the amount of motion given to the two halves of the object-glass. In the Yale heliometer this motion is about two degrees. Another advantage is the absence of either the bright webs or the bright field of the ordinary micrometer; but this is counterbalanced to some extent by the necessity of making the heliometer object-glass smaller than is usual in equatorials.

The difficulties and expense of construction of the modern heliometer, the fact that it is a special instrument to be devoted to measuring rather than to viewing, and the less difficulty of manipulation of meridian instruments and equatorials, led to the comparative neglect of the heliometer by English-speaking people until the erection of the Oxford heliometer of 190 mm. aperture. Lord Lindsay's admirable volume (*Dun Echt obs. publ.*, vol. ii.), describing his heliometer of 107 mm. aperture, presented in a very forcible manner the precision attained in measurements with comparatively small instruments. An inspection of the measurements executed with the instruments at Breslau (76 mm. aperture), Königsberg (158 mm.), Bonn (162 mm.), and Strasburg (76 mm.) shows a precision for distances over 1 minute not equalled by any other measurements made at the same period by instruments of another class.

The belief that a heliometer of the largest size, and built according to the most recent theories as to material, form, and symmetrical arrangement of parts, would be an important adjunct to the instrumental resources of American astronomy, led to the writer's recommending to the Yale observatory board the acquisition of such an instrument.

The contract with the Messrs. Repsold bears the date of June 11, 1880. The heliometer was erected in Repsold's shops in January, 1882, for inspection, and arrived in New York the following May. About the beginning of September it was in place in the west tower of the observatory.

The figure shows it as erected in Repsold's shop at Hamburg, and without its tripod foot. The object-glass is mounted in the rectangular metal frame A, which contains the two sliding-pieces holding the object-glass halves, which rest on four cylindrical surfaces each $107 \times 13$ mm., and having a radius 125 mm. less than the focal length of the object-glass. The large rotating disc B contains three sectors of different thicknesses of wire gauze, which can be swung over either object-glass half, to diminish the apparent brightness of either image. This whole head can be rotated in position angle by means of the shallow sheet-iron cylinder, which has a rack with its appropriate gearing attached to it. By this device the motion in position angle is as expeditious as in the common form of position micrometer. The position circle is at P. The slow motions and clamps for all the circles are brought within easy reach of the eye-piece E, by a number of ingenious mechanical devices.

The two small brass oil-lamps, which are carried at the extremities of long arms to avoid their heating effects on the instrument, by a careful economy of the light, and a beautiful arrangement of lenses and mirrors, illuminate the object-glass platinum scales, the scale metallic thermometer, and both the position and declination circle indices, which are all read by their appropriate microscope micrometers projecting from within the cylinder C. The telescope tube is of steel, the circle graduations are on silver; the column axes and counterpoises are of iron, and rest upon a massive tripod foot of 0.85 m. radius. The distance from the surface of the granite capstone on which the tripod foot rests, to the intersection of the polar and declination axis, is 2.9 m. The clockwork, with its connecting rod, is shown at D.

The more important instrumental constants are as follows: aperture, 155 mm.; focal length, 2,495 mm.; maximum arc to be measured, 2°; magnifying power of the eye-pieces, 90, 126, 159, 245. The scale micrometer has a value of $0''.25$ for one division of its head; while the hour circle, declination circle, and position circle micrometer divisions have values of $1^s$, $10''$


THE YALE OBSERVATORY HELIOMETER.

and 10″ respectively. The aperture of the finder is 62 mm. The whole instrument is an exquisite piece of mechanical workmanship, and for both design and execution the makers are entitled to the highest praise.

The construction of the object-glass, first offered to the Clarks, but declined by them because of the subsequent cutting in two, was accomplished by Merz of Munich. Its performance, using the Steinheil achromatic eyepieces, is an agreeable surprise. With either half the images are as sharp as with a good four-inch telescope. With the images superposed, there is a loss of the best definition; and this arises from the practical impossibility of adjusting the two halves of such an object-glass so that the images will be absolutely superposed. In actual observing, the greatest difficulty in the way of exact measurement is found in a want of similarity in the atmospheric conditions affecting two celestial objects which are supposably near enough to be influenced alike. Thus the two opposite limbs of the sun, except in the very best observing weather, do not maintain a steady contact together when heliometrically observed, but vibrate, alternately lapping over and receding from each other. In the observations of the last transit of Venus, this peculiarity presented the curious effect of a rapid breaking and forming of a ligament analogous to the 'black drop' described by the older observers when the limbs of Venus and the sun were in contact.

The model on which the whole instrument is constructed is a very great improvement on any previous heliometer, so far as lessening the observer's fatigue is concerned. Every motion is controlled, and every scale and circle is read, by the observer without leaving his seat.

With the cylindical bearings of the object-glass cells, the image distortion for measures up to 2° is rendered extremely small; by the rapid rotation in position angle, and equal rapidity in distance settings, the observer is no longer fatigued by manipulation; and it can be said that in this instrument the heliometer shows itself to be a measuring-machine of the highest precision. LEONARD WALDO.

## *NOTE ON THE OBSERVATIONS OF THE TRANSIT OF VENUS, 1882, AT THE LICK OBSERVATORY.*

BY invitation of Capt. R. S. Floyd, president of the trustees of the James Lick trust, I went to Mount Hamilton to direct the observations of the transit of Venus at the Lick Observatory. The chief instrument of the equipment which the trustees had provided in time for observing the transit was the horizontal photoheliograph, which is essentially similar to those employed by the American commission on the occasion of the transit of 1874, as well as that of 1882, and which are described by Professor Newcomb in the first part of the American observations of the transit of Venus of 1874. The Lick photoheliograph, like all the others, has an objective five inches in diameter; and its focal length is almost exactly forty feet. The heliostat mirror, an unsilvered disk of glass, is seven inches in diameter, and was mounted on a pier adjacent to that which supported the objective. A third pier, coming up in the interior of the photographic house, supported the plate-holder; and all three piers were laid up of brick, their foundation being in the rock of the mountain summit.

I arrived at the observatory in the evening of Nov. 21. The photoheliograph had, in the main, been mounted and got in readiness before that time by Mr. Fraser, the superintendent of construction of the observatory. It remained to complete the unfinished portions of the instrument, to mount and fully adjust the same, to modify some details which had been unsuitably constructed, and to make sure of the convenient and effective working of every part. Especial attention was given to the accurate determination of the position of the focal plane of the objective; and the method adopted — being nothing short of a critical examination, by many persons independently, of several sets of trial-plates exposed at varying distances from the objective — finally indicated the true setting of the plate-holder with much more than the required precision. Great care was taken to insure the perfect definition and figure of all the pictures, and to prevent the mishap of fogged plates from scattering and extraneous light. Much time was consumed in this way in the preparatory work, but we had more than sufficient compensation in the superior character of the photographs of Venus in transit. All these were taken by the wet process, and the photographic operations were in charge of Mr. Lovell of Amherst.

During the important days of the transit-period, the meteorological conditions on Mount Hamilton were especially favorable. At midnight, Nov. 30, the sky cleared, after three and a half days of continuously cloudy weather. From that time until the afternoon of Dec. 7 we saw no cloud, day nor night, which could in the least interfere with any observation we had to make. Thin cirrus was float-

ing above the mountain summit on the morning of the 2d, but it had vanished completely within two hours; and on three or four occasions clouds were observed very near the horizon, but they never rose. Fitful gusts of wind prevailed night and day the 3d and 4th, and the morning of the 5th; but, about noon this latter day, a period of the utmost tranquillity set in, and lasted for fifty or sixty hours, the temperature ranging only between sixty and seventy degrees.

Dec. 6 the sun rose about seven o'clock, with Venus a good way on its disk. The first sensitive plate was exposed at eleven minutes after seven, the slit being three inches wide, and the exposure a second and a half long; but a very faint image was all that came out on the plate in developing. Six minutes later, with an exposure of one second, a picture sufficiently intense for measurement was obtained; but the vertical diameter of the sun was about a quarter of an inch, or one-eighteenth part, shorter than the horizontal one. Something like a half-hour later, very satisfactory pictures began to be obtained, with the slit an inch wide, and an exposure less than half a second long. By twenty minutes past nine the slit had been reduced in width to 0.25 in., and was kept at this setting throughout the remainder of the transit, the exposures varying only slightly from 0.25 sec. in length. At twenty-two minutes before twelve the last exposure preceding interior contact at egress was made, and subsequently ten additional photographs were taken between the two contacts. The total number of plates exposed was a hundred and forty-seven, and about five-sixths of them will be available for exact micrometric measurement. Their number and quality are about as follow: A signifying a plate of the first order of definition, and any two successive grades being separated by only a slight variation in quality: —

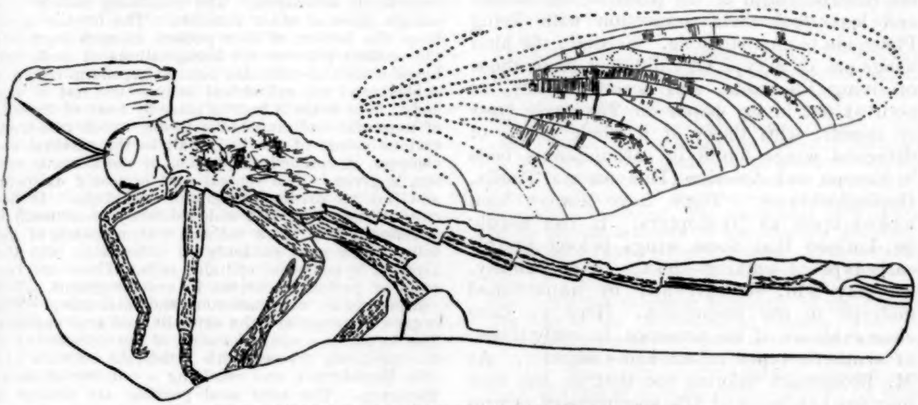
| Grade. | No. of Photographs. | Grade. | No. of Photographs. |
|---|---|---|---|
| A | 71 | B— | 3 |
| A— | 23 | C | 4 |
| B+ | 13 | | — |
| B | 9 | Total, | 123 |

The record of the times of exposure of these photographs was kept by two chronometers independently, one record being automatic. The original photographic record, and such parts of the photoheliograph as have yet to be investigated, together with the greater part of the photographs themselves, are now stored for safe-keeping in the vault of the observatory on the mountain.

No other observations of importance were attempted, except those of the two contacts at egress: these being observed by Capt. Floyd, with the twelve-inch equatorial, aperture reduced to six inches; and by myself, with the four-inch transit instrument. DAVID P. TODD.

## A GIGANTIC WALKING-STICK FROM THE COAL.

WE owe to the favor of M. Charles Brongniart of Paris, sketches of an enormous insect from the carboniferous beds of Commentry, France, which we have reproduced upon this page; in short preliminary notices, given last December to the Paris academy and the geo-



TITANOPHASMA FAYOLI BRONGNIAT. — ONE-FOURTH NATURAL SIZE.

logical society of France, he has named it Titanophasma Fayoli. The interest attaching to this remarkable creature, which has not before been figured, and to another somewhat smaller species published by him five years since under the name of Protophasma Dumasii, is twofold. First: scarcely any group of Orthoptera is so specialized as the Phasmida, or walking-sticks; and one would naturally look upon these bizarre creatures as the last term in a long series of forms in a special line of development. They had never been found fossil, excepting in one or two fragments in amber, when suddenly the upper coal-measures of Commentry revealed a considerable number of forms, of which M. Brongniart has only described two. He points out, that they differ from modern types in certain features, such as the relative length of the parts of the thorax and legs; but their connection with living Phasmida is unmistakable. Second: the hind wings are of a type very different from those of living Phasmida, and accord closely, as pointed out in my paper on *The early types of insects*, with those of a whole group of detached wings found in carboniferous beds in Europe and America (Dictyoneura, Paolia, Haplophlebium). These have always been looked upon as Neuroptera. It can hardly be doubted that these wings belong to this early type of walking-sticks, — a probability, we may add, strengthened by unpublished material in our possession. Here we have clear evidence of the presence, in early times, of synthetic types of marked character. As M. Brongniart informs me that he has now over five hundred and fifty specimens of arthropod remains from Commentry alone, and as our own Mazon-Creek beds have doubtless yielded as many, we may look for many new revelations concerning the early insect fauna of our globe. I am already acquainted with half a dozen or more species of Dictyoneura and allied genera from our American coal-fields, notably from Pennsylvania. The figures we give are from M. Brongniart's sketches, reduced lineally one-half. The body is that of the original specimen of Titanophasma described in the *Comptes rendus* of Dec. 11. The wing, his latest discovery, and not yet described, has merely been mentioned by M. Brongniart, in the bulletin of the entomological society of France: it was found detached in the same beds, and is conjectured by him, not without reason, to belong to the same or a closely allied species. Of Protophasma, specimens have been found with the wings attached to the body. SAMUEL H. SCUDDER.

## *ANATOMY AND HISTOLOGY OF POLYOPHTHALMUS.*

THIS interesting genus, which was first discovered by Dujardin in 1839, and more fully described by Quatrefages in 1850, is the subject of a fine monograph by E. Meyer in the *Archiv für mikroskopische anatomie*, xxi. 769. The transparent worm is 15-18 mm. long; has twenty-eight bristle-bearing segments, followed by eight smooth, very small ones, none of which are marked externally. The bristles form two rows on each side. Most remarkable are the eyes; of which there are three on the head, and several pairs on the body. In P. pictus, the species investigated by Meyer, there are twelve such pairs, on as many segments. The external cuticula is of nearly uniform thickness, except over the sensory organs, where it is thinned out; but the hypodermis varies considerably, and is composed of narrow cylinder cells and relatively large unicellular glands, which last have granular contents, an oval nucleus, and a cross-shaped opening through the cuticula for the duct. The external coat of annular muscles is very imperfectly developed. The remaining muscles resemble those of other annelids. The bristles arise from the bottom of four pockets in each segment; the pockets (*bursae*) are invaginations of both the hypodermis and cuticula; but the hypoderm cells are cubical, and not cylindrical as over the rest of the body. The brain is kept in place by a set of threads of muscular and connective tissue, which run from various points of the body-wall to the cerebral envelopes. A detailed description of the nervous system is given. The ventral cord is nearly uniform, and has no distinct ganglionic swellings. It lies close against the skin, which directly underneath it is reduced to a thick cuticula with a matrix of flat cells, which pass suddenly on either side into the layer of hypodermal cylinder cells. There are two pairs of peripheral nerves in every segment. The sensory organs are numerous and interesting. The organs of touch are the cephalic and anal papillae. The former is a small elevation of the integument of the forehead, covered with a delicate cuticula and thin hypodermis, and receiving a number of nerve filaments. The nine anal papillae are similar in structure, but project more. There are also the so-called lateral organs, a pair in each bristle-bearing segment, which are probably homologous with the *seitenorgane* discovered by Eisig in the Capitellidae. They lie between the two bristle pockets of each segment, and have the form of hemispherical projections, probably covered in life with free sensory hairs arising from the modified hypodermal cells, which rest upon a peripheral ganglion, from which they are separated by a thin membrane; the membrane is pierced by the cells to establish their connection with the ganglion. There are beaker-shaped organs, having evident resemblance with those of fishes and the Capitellidae, but present only in a single cephalic pair. There is also a pair of ciliated pits of horse-shoe shape on the oral segment. These pits are in structure quite complicated; and their bottom has hair-bearing sensory cells, which are greatly elongated, have rod-like nuclei, and rest upon a ganglionic layer, to which runs a large special nerve. There is an evident histological similarity between the ciliated pits, the beaker-shaped organs, and the lateral organs. The lateral eyes are of two sizes, those upon the eighth to the fifteenth segments, both inclusive, being nearly twice as large as the four other pairs: they all lie close against the integument, the overlying cuticula and hypodermis being both very much thinned. The

oval lens lies close against the hypodermis, and can be strongly stained with haematoxylin. From the inner surface of the lens depend a cluster of prismatic cells, with nuclei in their bases, or ends away from the lens. These cells fill up the interior of the eye, and are enclosed in an envelope, which is fibrous, pigmented, and nucleated. The fibres probably are, in part at least, ramifications of the eye-nerve; the envelope is separated from the inner cells (so-called *glasskörper*) by a limiting membrane. These eyes conform, therefore, in their structure, with the known type of annelidan eyes. The three cephalic eyes are embedded in the brain. Their most remarkable peculiarity is the extension of the envelope of the eyes over the lenses, where it is much thickened. Each eye has three lenses (in P. pictus), but otherwise is similar in structure to the lateral eyes. Three pear-shaped vesicles lie beside the eyes: these Meyer believes to be probably otocysts. The digestive tract has five divisions: 1°, the mouth cavity, is a rather long cylindrical tube; 2°, the pharynx, extends in many windings and folds to the end of the fifth body-segment; it is quite muscular, and has numerous peculiar glands opening into it; these two parts appear to correspond to the fore-gut, while 3°, the oesophagus, seems rather a portion of the midgut, since it is lined with ciliated epithelium; 4°, the largest division or stomach proper, which has two ventrally placed glandular coeca at its anterior end; the coeca are lined with an epithelium composed of two distinct kinds of cylinder cells; the stomach has an external wall of fibrous and connective tissue, within which is a close network of large capillaries, which gradually becomes more and more irregular posteriorly; the epithelium over the capillaries is ciliated, but over each mesh there is a single cell, which extends down between the vessels, and itself forms a complete glandular bag, and represents a hitherto unknown type of cell-form; 5°, the endgut, is very short. The vascular system is well developed, and is described in detail. A short account of the body cavity is given; the structure of the segmental organs was not elucidated. The sexual organs have been accurately described by Quatrefages and Claparède. C. S. MINOT.

## THE GLACIAL THEORY BEFORE THE PHILADELPHIA ACADEMY.

AT the meeting of the Academy of natural sciences of Philadelphia, Feb. 13, Prof. Angelo Heilprin, referring to the subject of glaciation, stated that in his opinion the vast ice-sheet which is generally supposed to have covered, during the great 'ice age,' a considerable portion of the northern region of the European and North American continents, could not have had its origin, as is maintained by most geologists, in a polar ice-cap; since it may be reasonably doubted whether any accumulation of snow and ice in the far north could ever have attained a magnitude (in height) sufficient to have propelled a glacier with an estimated thickness of several thousands of feet, to a distance of hundreds of miles, and up mountain-slopes to an elevation of five or six thousand feet.

The height of such snow-accumulation must necessarily depend upon two circumstances: 1°, the quantity of aqueous precipitation; and, 2°, the upper limit in the atmosphere to which clouds may attain. It is well known that as a rule clouds rise highest in the regions of highest temperatures, — the equatorial, — where the vapor absorption by the atmosphere is greatest; and, for a similar reason, higher in summer than in winter. The minimum rise will therefore take place in the polar regions, and necessarily during the polar winter. High (discharge) clouds in the extreme north are stated by arctic explorers to be a rarity, and hence precipitation in the form of snow must be restricted to a comparatively low atmospheric zone.

No great accumulation of snow can take place above this zone, which must consequently be of the height of the ice-cap. As a matter of fact, the officers of the late arctic expedition under Sir George Nares observed that the crests of the greater elevations were devoid of snow, and that in the winter-months there was altogether, even in the low lands, very little precipitation, heavy precipitation beginning only with the spring-months. The greatest snow-clad elevation in Greenland is Washington Land, supposed to be 6,000 feet, which gives origin to the great Humboldt glacier. Although this peak is completely buried in snow (of undetermined thickness), it may be safely doubted whether, unless with a warmer climate, snow of any great thickness could possibly accumulate on a summit of much greater height. If not, the elevation, in the opinion of the speaker, was entirely inadequate to account for the phenomenon of glacial propulsion southward to the extent required by geologists.

Prof. H. Carvill Lewis remarked, that, notwithstanding the difficulties in the way of a theoretical explanation, the fact of a great continuous glacier at the time of maximum glaciation seemed clearly indicated, at least in America, by the numerous observations recently made. He described the extent of the glacier in America, as indicated by its terminal moraine, and stated that the close similarity of its phenomena at distant portions of its southern edge indicated a continuous ice-sheet. The continuous motion of its upper portion is shown by the uniform direction of glacial striae upon elevated points. Thus the southwest direction of the striae upon the mountain-tops of northeastern Pennsylvania was identical with that upon the Overlook Mountain of the Catskills and that of the Laurentian of Canada. The striae at lower elevations conformed more or less to the valleys, and did not indicate the general movement of the ice. The thickness of the glacier increased northward, the rate of increase diminishing as its source is approached. This latter point has not heretofore been appreciated, although observed some time ago by Dr. Hayes in the case of the Greenland glacier.

Recent observations by the speaker in Pennsylvania had shown the glacier to be 800 feet thick at a point five miles north of its extreme southern edge, and 2,000 feet thick at a point eight miles from its edge, while it was only about 3,100 feet thick one hundred miles farther north-east, and about 5,000 feet thick three hundred miles back from its edge. The amount of erosion it caused upon rock surfaces was in some degree a measure of its thickness, being far greater in Canada, even upon the hard Laurentian granites of that region, than in Pennsylvania, where even soft rocks were but slightly eroded.

The present thickness of the glacier in central Greenland was considered, and the magnitude of certain icebergs detached from it given. A friend of the speaker had within a few months seen a floating iceberg near the coast of Newfoundland which stood 800 feet above the water by measurement, and may have been therefore nearly a mile in depth. Dr. Hayes saw an iceberg aground in water nearly half a mile deep.

That the great glacier flowed up steep inclines, was abundantly proven by recent observations of the speaker in Pennsylvania. He instanced the striae

covering the north flank of the Kittatinny Mountain; and a bowlder of limestone perched on the summit, which, within a distance of three miles, had been carried up eight hundred feet of vertical distance.

Referring to a paper recently published by Mr. W. J. McGee, who found difficulties similar to those of Professor Heilprin in the assumption of a polar ice-cap of great thickness, and who imagined the glacier to increase by additions to its outer rim, Professor Lewis held, that the single fact of the transportation by the glacier of far-travelled bowlders to its terminal moraine was a fatal objection to any such hypothesis. Nor did he believe that the hypothesis adopted by Professor Dana and others, of a great elevation of land in the north, was a probable one. The facts now in the possession of geologists do not indicate such a great and local upheaval as required by that hypothesis.

An explanation therefore must still be sought for the southward flow of a continuous ice-sheet, — a flow in some regions up-hill. The action of gravity was certainly not sufficient. Even in the case of the downward flow of the steeply inclined Swiss glaciers, it had been shown that gravity was more than counterbalanced by friction of the sides and bottom, and those glaciers moved by reason of an inherent moving power of the molecules of the ice. It was probable that a similar action occurred in the great continental glacier. He suggested, therefore, a hypothesis which, while preserving the unity of the glacier, as indicated by observed facts, neither assumed an unreasonable land-elevation in polar regions, nor required a thickness of ice so great as to be open to the objections of the last speaker. He suggested that the ice-cap flowed south simply because it flowed toward a source of heat. Such flow does not depend upon gravity, but would occur in a flat field of ice, or possibly even up a slight incline toward a warmer temperature. Upon this hypothesis the ice need not to have been more than a few times its present thickness in Greenland to account for all existing phenomena.

## *AN EARLY STATEMENT OF THE DEFLECTIVE EFFECT OF THE EARTH'S ROTATION.*

A CORRECT knowledge of the deflective effect of the earth's rotation on the motion of bodies on its surface is generally accounted the result of studies made within the last twenty-five years. First in 1856, and more fully in 1859, Mr. William Ferrel of Nashville, Tenn., now of Washington, made the general statement, that, "in whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern" (*Math. monthly*, 1859, i. 307); and gave, by a rigorous analytical treatment of the question, a quantitative measure of this force, showing that it depended on the sine of the latitude of the body, but not at all on the direction of its motion. A similar but less comprehensive result was arrived at about the same time by Babinet and others (*Comptes rendus*, xlix. 1859); and since then the subject has been treated by many writers, among whom may be mentioned Buff, Finger, Guldberg and Mohn, and Sprung. It has, however, also been disputed by some authors, as Bertrand and Benoni, who erroneously hold to the old idea, first suggested by Hadley (1735), and recalled (it would seem independently) by De Luc (1779), Dalton (1793), and Dove (1835), that the deflective effect is greatest on motions in the meridian and nothing on east-and-west lines; and this incorrect view is but slowly disappearing from the text-books in general use.

It is the object of this note to call attention to an early statement of the law of deflection, that has never, so far as I can learn, received due credit. In 1843 Mr. Charles Tracy, now of New York, read a paper 'On the rotary action of storms' before the Utica (N. Y.) society of natural history; this was published in the American journal of science (xlv. 1843, 65–72), and the paragraphs quoted below are taken from it. It will readily be perceived that this explanation is far in advance of Dove's; although it lacks the consideration of the effect of centrifugal force and of the preservation of areas, to be a full statement of the matter. Mr. Tracy thought, in accordance with Espy's theories, that there must exist "a qualified central tendency of the air, in both the general storms and the smaller tornadoes" (p. 67); and in order to develop a uniform rotary movement in these centripetal winds, he looked to "the forces generated by the earth's diurnal revolution" (p. 66). In every storm, "the incoming air may be regarded as a succession of rings taken off the surrounding atmosphere, and moving slowly at first, but swifter as they proceed towards the centre." In virtue of the law of deviation, every ring "begins to revolve when far from the centre, turns more and more as it draws near it, and finally as it gathers about the central spot all its forces are resolved into a simple whirl" (p. 69). The law of deviation is illustrated by appropriate figures for the two hemispheres, and is explained as follows. (Its *direct* application to the tornado and water-spout is probably incorrect, as Mr. Ferrel has shown.) "The relative motions of the parts of a small circular space on the earth's surface, by reason of the diurnal revolution, are precisely what they would be if the same circular space revolved upon an axis passing through its centre parallel to the axis of the globe. If such space be regarded as a plane revolving about such supposed axis, then the relative motions of its parts are the same as if the plane revolved about its centre upon an axis perpendicular to the plane itself; with this modification, that an entire revolution on the axis perpendicular to the plane would not be accomplished in twenty-four hours. Such plane daily performs such part of a full revolution about such perpendicular axis as the sine of the latitude of its centre is of radius. The plane itself — the field over which a storm or a tornado or a water-spout is forming — is in the condition of a whirling table. Hence the tendency to rotary action in every quarter of the storm is equal, and all the forces which propel the air toward the centre co-operate in harmony to cause the revolution" (p. 72). The special value of this statement lies in the proof that motions in all directions are deflected equally; but on account of the omissions above named only one-half of the total deflective force is accounted for. W. M. DAVIS.

## *LETTERS TO THE EDITOR.*

### 'Mother of petre' and 'mother of vinegar.'

CHEMISTS were not a little interested a few years since by the discovery, first announced by Alexander Muller in Germany, and afterwards by Schloesing and Muntz in France, that the formation of saltpetre in nature, and of other nitric compounds as well, is in some way connected with the presence and action of a living 'ferment,' much in the same way that the formation of alcohol in the brew-house or distil-

lery is due to the presence and growth of the yeast-fungus. At the time of the publication of Schloesing and Muntz's memoir, it was remarked in corroboration of their view, that tradition has taught, that in the days when 'saltpetre plantations' or 'saltpetre yards' were worked in Europe, in order to obtain a supply of the nitrate for making gunpowder, pains were taken to use the earth of a yard over and over again, after the nitrate had been leached from it; and that, in order to insure success, when a new yard was to be started, some earth had to be brought from an old yard, and mixed with the new earth, — all of which went to show a recognition of the truth, that something useful for the process of nitrification was contained in the old earth. But the wisdom of the fathers is expressed even more emphatically in the following citation from the 'Diary of Samuel Sewall,' recently published by the Massachusetts historical society (see 'Sewall papers,' vol. 2, p. 10, of the preliminary 'Miscellaneous items'). It appears that in the year 1686 Judge Sewall copied upon the cover of his journal this receipt: —

"To make a salt-petre bed. All the sward of the ground is to be taken off or trenched in, and the stones to be taken clean out as deep as the trench. Then get the best and richest mould you can, and fill up the trench according as you will make it in greatness — length or depth as you see cause. When the ground is made clean and fitting, turn over the ground and trench it in again, and as you trench it in mix it with strong lime about a tenth or sixth part; and the Seed-Petre, or Mother of Petre, and hen or pigeon's dung as much as you can get, the more the better. And after 'tis trenched in as above, let all the butcher's blood and lees of wine be mixed often with the upper part of the mould about half a foot down, that it be not lost or run away from the bed or bank. Let the bank be made upon rising ground, and a ditch about it, that the water rest not, nor run into the petre-bed; with a dry house over it, to keep it from rain."

Surely it is something more than a curious coincidence that our forefathers should have thus spoken of the 'mother of petre' as they did habitually of the 'mother of vinegar.' In the face of expressions so distinct as these, it is impossible, as a matter of history, to deny that just conceptions of nitrification and acetification were current long ago. It is, perhaps, the fault of their descendants, rather than of themselves, that this knowledge of our ancestors was not more firmly grasped or sooner formulated with precision. F. H. STORER.

### Archeological frauds.

As an illustration of the demand and supply of archeological material, I will call attention to a carved stone representing a naked child about two feet in length, which was said to have been dug up near the Hot Springs in Arkansas. The carving was partly enclosed by a cement, which, it was said, covered the stone when it was found. This was received at the Peabody museum, with its history, apparently well authenticated, describing it as an antique. This piece of carving proved to be a child of the 'Cardiff giant' family. The fraud was unquestionable; and the image was returned to its owner with a full statement of the evidence against it, and the request that in the interest of science the object should be destroyed. Since then I have heard nothing more of it, and in case it has not been destroyed this notice will serve to put others on their guard. This is, however, but one of the many fraudulent specimens offered for sale; and we have received a number of pipes, tubes, dishes, ceremonial and other objects, made in Philadelphia, and sold as having been found in such or such a locality. The variety of these articles made by the Philadelphia manufacturer, and the character of the work, are such that many have found their way into collections in this country, and not a few have supplied the foreign demand for American antiquities. A manufacturer in Indiana confines his attention chiefly to 'mound-builders' pipes,' which are carved from stone, and offered in a systematic method to collectors. In Ohio a large business has been done in the so-called gorgets, cut from blue slate, and in hematite celts. In southern Illinois, a few years ago, many specimens of pottery were made, until the demand fell off so that one manufacturer acknowledged that he was no longer paid for his trouble by their sale. Another man who made this pottery is, I believe, no longer living; but much of his work is still extant. This list might be lengthened; but it is already sufficient to show that the demand for 'antiquities' is considerable in this country, and that we are not behind the old world in keeping up the supply. F. W. PUTNAM.

Cambridge, Feb. 19.

---

## AMERICAN INSTITUTE OF MINING ENGINEERS.

THE American institute of mining engineers, organized in 1871, and consisting at that time of mining and mechanical engineers, metallurgists, and chemists, held its second February meeting in Boston, in 1873, with a membership of about two hundred and fifty. Since that time the American chemical society and the Society of mechanical engineers have been formed, in a measure limiting the field of the institute to the mining engineers proper, the metallurgists, those chemists who are engaged on the problems connected with the profitable extraction and working of metals, and those geologists whose work lies in the same direction. But, even with this specialization of the aims of the institute, it has just held its twelfth annual meeting in Boston, Feb. 20–23; and the membership at present numbers over twelve hundred.

The decade which has elapsed between these two meetings has witnessed a most marvellous growth of mining and metallurgical enterprises. It is now very generally recognized that our mineral resources in extent and richness rival those of any other country. It is, on the other hand, true that the mining-lands of America present obstacles to the extraction and transportation of their mineral wealth such as no

other country has to contend with. The ores, too, are of much more refractory nature, and the laws of the deposits very different from those that govern the veins and beds of the eastern continent.

The novelty and the difficulty have attracted to this field of research a number of Americans of liberal education fitted in the schools at home and abroad. The magnitude of the obstacles and the difficulty of the problems encountered in the field have only served to stimulate their mental energies, and have drawn hither a goodly number of foreign scientific and practical men, who have sought in this untried field an opportunity to win greater laurels than was offered by the better-known regions of Europe. All these causes have brought together a body of men of a degree of keenness of intellect, versatility of powers, and acquired skill in overcoming difficulty, which is rarely found in any association at home or abroad.

To the meetings they bring the freshest thought on the newest problems; and those of kindred pursuits have the means of informing themselves as to the progress in their several departments.

Besides the February meeting, which has always been held in some eastern city, one or two expeditions are taken each year to mining regions, where methods and processes are carefully examined and criticised. This close contact of the laboratory and the office with the field results in a union of theoretical and practical science which cannot fail to effect a great development in the metallurgical art.

The Boston meeting, which has just closed, was attended by about seventy-five members. Twenty-eight papers were presented, of which thirteen were read and discussed. Abstracts of these appear in the following pages. Some idea of the range of thought at one of these meetings may be gained from the following classification of the papers: In metallurgical subjects, ten papers were offered; in mining and ore-dressing, six; in geology, five; in analytical chemistry, three; in characters of iron and steel, two; and two unclassified.

Besides the five sessions for the reading of papers, there were three excursions to works of engineering interest. The first was to the pumping-station of the new sewerage system at Old-Harbor Point. The chief objects of interest were the two great pumping-engines, each with two plungers, four feet in diameter, and nine feet stroke. One of the engines was started for the benefit of the visitors, and they were informed that it was pumping about thirty-seven million gallons per day. One of these pumps would be able to pump the Charles River dry if its outlet to the sea were stopped by a dam. The sewage is here lifted forty-three feet in order to gain column enough to carry it out to Moon Island. On the way home the party visited the Norway iron-works, and inspected the new petroleum furnaces, which are said to replace one ton of coal with two barrels of crude petroleum; and also the Billings cold-drawn shafting apparatus. Later the Carson trenching apparatus was inspected, whereby a sewer may be constructed through the crowded streets without stopping the travel.

The second excursion was to see the celebrated testing-machine at the Watertown arsenal. No European nation has a testing-machine of equal capacity and precision of measurement; a piece of steel tested was a flat bar of the manufacture of the Norway iron-works, of twelve-hundredths carbon. Its length was 80 inches; width, 5.85 inches; thickness, one inch. Under tension it stretched eighteen inches, and broke when a force of 288,300 pounds had been applied, which is 49,282 pounds to the square inch. In the afternoon several of the buildings of Harvard university were visited, including the Museum of comparative zoölogy, the Peabody museum of American archeology, the gymnasium, and the chemical laboratory and museum of minerals in Boylston Hall. A lunch was served in Memorial Hall.

The third excursion, was made to Lowell; and the party visited a cotton-mill and print-works, besides a carpet- and a hosiery-mill, all of which proved of great interest to the members living out of New England.

### Microscopic analysis of the structure of iron and steel.

BY J. C. BAYLES OF NEW YORK.

After briefly reviewing the work of A. Martens of Berlin and Dr. H. C. Sorby of Sheffield in this field of research, Mr. Bayles considered the methods of preparing specimens for microscopic study which in practice he had found to give the best results, and continued: The first step to be taken in practical microscopy is the training of the eye to observe what may be seen without the aid of a lens. This is accomplished by the patient examination of characteristic fractures, and noting similarities and differences. After the naked eye has become familiarized with all it can see, the student should continue his investigations assisted by a hand-lens with a power of from two to three diameters, and absolutely achromatic. Specimens to be studied with a view to determining their internal structures should be surfaced in a planer, and smoothed by draw-filing in the direction of the fibre. The surface thus obtained is treated with slightly diluted nitric acid, which gives a rapid and wide development of the structure, which may be studied with advantage while it lasts, and will prepare the student for finer work. For fine development more care and time are needed. After planing, the surface of the metal is ground with fine emery, or under a metallic mirror-grinder. It is then treated with acid, Mr. Bayles describing the manner in great detail. A thorough development with weak acid requires from twenty-four hours to six days, according to the composition of the metal. Small specimens are prepared by planing down from the back to a thickness of $\frac{1}{32}$ to $\frac{1}{16}$ of an inch. The planed face is then ground and surfaced on a fine whetstone, developed with weak acid, and mounted between glasses with Canada balsam. In selecting a microscope, care should be taken that the lenses give a good definition, that there is no 'shake' or lateral motion in the adjustments for focus, and then the table should admit of inclination at any angle found most convenient for observation. Concerning the results to be expected from the microscopic analysis of metals, Mr. Bayles expressed the belief that it opens a vast field of knowledge not yet reached by either chemical analysis or physical test. There are many conditions, the result of changes produced by mechanical treatment, to which chemical analysis gives no clew, and which are detected, but not explained, by the tests of the physical laboratory. The microscope will, no doubt, explain many of the mysterious changes which occur in metals of given chemical composition under different conditions, and will give the metallurgist an opportunity of studying the anatomy and physiology of iron and steel, which, in a most important sense, will supplement analysis and mechanical test, which have thus far, to some extent, run in parallel lines. When, between the report of analysis and the fracture of the broken test-piece, we can place a polished longitudinal or cross-section of the material, its internal structure developed by acid, and admitting of careful microscopic study, we are furnished with the missing link in the chain of evidence required for a correct conclusion as to the nature of the material under investigation.

### Coal and iron of Alabama.

BY DR. T. STERRY HUNT OF MONTREAL.

After referring to the researches of Profs. R. P. Rothwell and Eugene Smith, and complimenting them in high terms on the results of their labors in that section, Dr. Hunt said that the existence of coal in Alabama had been known for half a century: it forms a part of the great Appalachian coal-basins, which lie principally upon the waters of the Ohio, and has an extent of 58,000 □ miles, including eastern Tennessee, the north-western corner of Georgia, and a large part of the state of Alabama. The principal part of these measures has an area of 5,000 □ miles; but on the east side are two small detached basins, — the Cahawba, 230 □ miles in extent, and the Coosa, 100 □ miles. They are separated from the main basin by narrow belts of older rocks a few miles in width; and there is no doubt that they are detached portions separated, — the one by a fault pure and simple, the other by an undulation which has overturned the folds, and has faulted them in some places. To the east of these, stretches the Coosa valley, a geographical feature of the greatest importance, being a continuation of the great limestone valley which runs up to Lake Champlain. On the eastern border of the valley is a great belt of crystalline rocks, of which the Blue Ridge, Hoosac Mountain, etc., are a part, and forming the great Atlantic belt from the hills of New England to Alabama. Next is a limestone valley forty or fifty miles in width. Then we have the North Mountain, which is the beginning of the great series of folds which make up the Alleghany Ridge, and formed of paleozoic rock which underlies the coal. To the west are the great coal-measures, essentially the same in character as those of Pennsylvania and Virginia. A peculiarity of the underlying bed of sedimental rock is its varying thickness, from 18,000 feet in Huntington County, Penn., and diminishing toward the south, until in some places in Alabama it has thinned down to 1,800 or even 1,000 feet of soft rock, sandstone, and shale.

The ores in the limestone valley are limonite, and the brown hematites found in Berkshire County, Mass., enormously developed; furnishing a large part of all the ore which is smelted, and practically inexhaustible for generations to come. In the mountain belt is another set of iron-ores, also important, — the red hematites of the Clinton group. Beyond that are coal and occasional clay ironstones, of secondary importance as regards amount. In the northern portion of these beds, especially in Pennsylvania, the North Mountains separate the coal and iron by distances of 100 miles or more, offering serious drawbacks, and increasing the cost of production; at the same time the Atlantic belt renders it impossible to reach the region by navigation. But a remarkable fact is the almost complete disappearance in Alabama of the two great mountain barriers before reaching the sea, being thinned out and worn and ground away. The southern rim of the basin is broken down, and the coal and iron are on a level with the navigable waters of the gulf at Mobile; bringing up the question of the importance of rendering the rivers navigable so as to reach the heart of the coal-region. The coal-measures to the south suffer no diminution in quantity or quality; but the bed-rocks are so upturned and folded and faulted, that within three or four miles the coal and iron are found together. A curious fact of the enormous fault — this great break in the stratification of nearly 10,000 feet — is, that it has brought up the hematite ores directly beside the coal in the Cahawba valley, so near that by the simple means of gravity they may be brought to a common point, reducing the cost of production to the lowest. To these geographical and geological conditions the region owes its future importance. It is the part of the country which is growing most rapidly in population, showing an increase in ten

years of 4[illegible]% against 30% for the nation; it includes the states where agriculture and the carrying trade are to be built up, requiring coal and iron; and they can be obtained under the most favorable conditions. Its significance was long ago noted by Isaac Lothian Bell, who found its ores richer and its fluxes much nearer than in Yorkshire; and he said that the region matched and more than matched anything in Great Britain. Abram Hewitt regarded it as important, reckoning not by the wages paid, but by the number of days of labor necessary to produce a given quantity. Dr. Hunt predicted a most remarkable future for the coal and iron regions of Alabama.

President Rothwell stated that he must disclaim any credit for original investigations, his first knowledge coming from a careful survey and plan made by Joseph Squires.

Dr. Hunt replied, that, had he been aware of it, he would have been glad to give due recognition to the labors of Mr. Squires.

### Changes in the structure of block-tin.

BY PROF. R. H. RICHARDS OF BOSTON.

The speaker exhibited a pig of the metal, which in December last appeared to be perfectly good malleable block-tin; Feb. 15, the pig was found to be brittle, and had undergone a change in its molecular condition which involved about half of the mass. It made itself apparent by enlargement in spots which took on a darker color, and which revealed a crystalline structure very like that of stibnite. It was surmised that the change was due to imperfect retorting, leaving in the tin a small percentage of the mercury with which the metal was originally treated; and an analysis of a portion of the pig, using a current of hydrogen at a bright red heat, showed by the direct method the presence of 2.62 parts of mercury to 97.24 of tin; or, by difference, 2.76% of mercury and 97.24% of tin.

Dr. T. Sterry Hunt said that such changes had been previously noted in tin supposed to be in a state of purity, the metal becoming so crystalline that it was almost ready to fall in pieces. Under certain conditions, very like those stated by Prof. Richards, it had been ascertained that block-tin would undergo these changes.

### A suggested cure for blast-furnace chills.

BY H. M. HOWE OF BOSTON.

These chills, as well known, are the results of a falling of the temperature below that needed for the fusion of the slag, from 1,800° C. to 1,900° C. The common remedies are the injection through the tuyeres of liquid petroleum, or of air-gas, and the increase in the temperature of the blast, rather than hastening the latter; since this tends to lower the temperature at the tuyeres, just as, up to a certain point, blowing a match, or fire, or candle, will increase its combustion, but beyond that point will decrease it. The difficulty with the use of liquid petroleum is, that it is not generated at a sufficiently high temperature, and the process of vaporizing it within the furnace also requires additional heat. He suggested, that instead there should be used vapor of petroleum or coal-gas, heated externally, so that the energy needed for that operation would not be taken out of the furnace. When cold liquid petroleum is used, there is not enough margin in temperature to avoid chills. The results of his observations were expressed by the following figures, the temperature being in centigrade degrees: —

| | INITIAL TEMPERATURE. | FINAL TEMPERATURE. | |
|---|---|---|---|
| | | Complete combustion. | Incomplete combustion. |
| Air-gas . . . . . . | 482 | 2383 | 1323 |
| Liquid petroleum . . | 15 | 2885 | 1698 |
| Vapor of petroleum . | 482 | 3967 | 2117 |

In discussing the paper, Dr. Raymond of Cambridge said, that, at the Durham furnace, a chill had caused a large scaffolding, which had fallen suddenly, and had choked up the hearth. Liquid petroleum introduced through the tuyeres, with the blast at 900° Fahr., had burned a large hole in the mass, although it was not thoroughly successful in doing away with the obstruction; but a very high temperature was produced within a few inches of the tuyeres. He questioned whether the petroleum in the form of a fine mist, or spray, would not give a higher result than the vapor.

A member said that the chills were produced by the formation of scaffoldings, which prevented the descent of the fuel, and the proper reducing atmosphere could not be maintained. He was of opinion that the petroleum vapor would not remedy this unless carbon were introduced with it. Mr. Howe replied that he would introduce an excess of the gas.

President Rothwell asked if the combination of carbonic oxide and hydrogen, known as water-gas, had been tried. In recent experiments in Germany, in pipe-making and for welding purposes, introduced with air it had given a very high temperature.

Mr. C. Constable, of Constableville, N.Y., thought that 'chilling,' as here used, was a misnomer; that the air of the blast was only capable of burning so much, and, when in excess, a portion of it was driven up in the furnace, and caused the scaffolding. His remedy was a reduction of the blast.

### The metallurgy of nickel in the United States.

BY PROF. W. P. BLAKE OF NEW HAVEN.

Nickel has for a long time, and until within a few years, been a compound rather than a simple element, so far as it was known commercially. It was extracted as a secondary product from cobalt spia, and of necessity was a very impure result, being contaminated with a great many other substances, especially arsenic, iron, and sulphur, which were present in small quantities, but sufficient to destroy, to a great extent, the true properties of the metal. In this respect nickel is essentially the same as iron, and these metals and steel offer many analogies when in a state of alloy or combination. For a long time cobalt was the principal object sought, and nickel was a by-product; but the production of artificial ultramarine diminished the demand for cobalt, and at the same time the introduction of nickel-plating and kindred industries increased the call for nickel, until now the conditions are reversed, and the latter metal is in the greater demand. But to the scientific chemists, who prepared nickel in a state of purity, its properties were not wholly unknown; yet between them there was a great diversity of opinion, — one declaring it to be malleable, and another the reverse. Its malleability was diminished by the presence of carbon or manganese; and, reduced by carbon, its ductility was less than that of zinc. These results, however, were confined to chemists and laboratories, and were not known to the arts; and the production of nickel con-

tinued as an alloy, with 2% or 3% of foreign matter, sufficient to destroy its malleability and ductility, and prevent its usefulness in the arts. The first demand for the metal was for nickel-plate, and next for making coins; being first used for the latter purpose in Switzerland in 1850, and in the United States in 1857, although as early as 1853 Booth of Philadelphia had made sample coins, and submitted them to the mint, but they were not accepted. The alloy varied from 5 parts of nickel and 95 of copper to 30 of nickel and 70 of copper. This country first adopted the ratio of 12 to 88; and at present, in the five-cent nickel coins, uses 25 parts of nickel to 75 of copper. Of these five-cent pieces there were issued up to June 30, 1876, the value of $7,000,000. Another large demand for the metal was occasioned by the discovery of the possibility of depositing it by the action of electricity.

Nickel ores are extensively distributed through the United States, more generally than is usually supposed. It is found with chrome ores in serpentine rocks which have a coating of nickel-oxide or emerald nickel, and is also commonly associated with magnetic pyrites; particularly in Connecticut, by the Hudson River, in New Jersey, and at Lancaster Gap, Penn., which is the chief source of the metal in this country. The general diffusion of nickel is pointed out by Dr. Hunt in the magnesian rock at Quebec; at Silver Harbor, on the shores of Lake Superior, is another supply; and a valuable deposit has been found in Nevada, whence last year there were shipped ten tons of the ore to Swansea. Another deposit, closely resembling that of New Caledonia, a hydrated silicate of nickel oxide, and carrying as high as 10% of the metal, has been discovered in Douglas County, in southern Oregon; the Lancaster-Gap ore contains only 1½% to 2% of nickel, with magnetic pyrites. A few years ago the discovery of the hydrated silicate at New Caledonia attracted a great deal of attention. It was at first thought that the deposit was small, and would rapidly be exhausted; but it has proved to be of sufficient extent to supply now nearly all the works of Europe, and is very pure.

In 1876 a remarkable series of objects was exhibited at Philadelphia by Professor Wharton, being nothing more nor less than a number of articles made by that gentleman of pure wrought nickel. They did not attract by any means the attention to which they were entitled; and the same fate befell them at Paris in 1878, where they seemed insignificant beside the splendid cases of alloyed products exhibited by the French workmen, these cases containing, however, not one piece of the pure metal of over three or four grains weight. Professor Blake called the attention of the chairman of the board of judges to these wrought-nickel goods. That official was inclined to be incredulous, but cut a small piece off a square bar, and took it to his laboratory. The next day he informed his associates, that this exhibit of Professor Wharton was beyond comparison, and that they were in the presence of one of the most important results of the age in this direction. This step paved the way to greater advances; and experiments were begun in Westphalia on the mechanical combination, or welding, of nickel with iron and steel. As a result there have been produced sheets of iron and steel coated with nickel on one or both sides, this end being accomplished by securing plates of the baser metal of proper surface, on which are laid the plates of nickel: these are then heated, and passed through rolls under high pressure. The thickness of the nickel is a tenth by weight on each side. The applications of this coated metal will suggest themselves. It is chiefly used in the manufacture of hollow-ware, being readily spun and pressed; and its advantages of lightness, strength, and infusibility, are apparent. These results have also been obtained by Professor Wharton at Camden, N.J.; who has also succeeded in making objects of cast-nickel, the door-knobs in his residence being of this material. There is a great future in this industry, which gives additional importance to all localities where nickel is found; and it is also of interest scientifically. A proposition has been made to use pure nickel for the magnetic needle, and one was exhibited at Paris in 1878. It was afterward presented to the French government, and a commission was appointed to test it: their report has not yet been made.

Professor Blake exhibited to the members of the institute several of the articles shown by Professor Wharton at Philadelphia and Paris. They included a knife, a bent bar, a horse-bit, etc. The bit, it was explained, had not been rubbed or polished since it was sent to Paris in 1878; yet it had not the slightest appearance of tarnish about it. There were also shown specimens of the hollow-ware made in Westphalia. In reply to questions, Professor Blake stated that these vessels were presumably harmless, as the nickel is not easily attacked by vegetable acids; and, further, that the experiment had been tried of feeding a dog on nickel-salts, on which the animal seemed to thrive. It is more economic and more rapid to coat the plates by rolling than by electrolysis.

### The Bower-Barff process.

BY MR. BOWER OF ENGLAND.

Mr. G. W. Maynard was announced to read a paper on the 'Bower-Barff process;' but he stated that Mr. Bower of England, one of the discoverers of the process, was present, and could do better justice to the subject. Mr. Bower said, that any process which has for its object the preservation of iron and steel from rust, and which will make these metals more applicable than they now are to the requirements of mankind, will be sure to meet with attention from all those who are either engaged in the extraction of the ore, its reduction to metal, or the subsequent application of the metal itself. With iron and steel rendered secure against corrosion, they will be used to an infinitely greater extent than they now are. The whole realm of science has therefore been explored in the attempt to discover some method by which the formed article may be preserved, leaving its strength undiminished by the action of rust. Paints, oils, varnishes, glazes, enamels, galvanizing, electro-depositing, and what is called 'inoxidizing,' are among the many systems now in vogue to effect the preservation of iron and steel from the corrosive action of air and water. The object of this paper is to show what may be done in protecting iron and steel from rust by forming upon their surface a film of magnetic oxide by an inexpensive process. Russian sheet-iron is less affected by exposure than the ordinary material because of this formation, but this was not known until Dr. Percy discovered it. That such a coating is produced is quite certain, but it is only an accident of manufacture. To Professor Barff is due the credit of being the first to deliberately undertake to coat iron and steel with magnetic oxide produced designedly for the purpose of protecting their surfaces from rust. Some sixteen or seventeen years ago my father was making a series of experiments in the production of heating gases, one set of them being on the decomposition of water by passing superheated steam through masses of red-hot iron. He noticed that the iron became less and less active, until it

ceased to decompose at all; when, on examining it, he noticed that it was coated with a kind of enamel. It at once occurred to him that the process in question might be used to obtain such a coating; but he found, after a few days' exposure of the iron to the atmosphere, that the coating scaled off, and he pursued the matter no farther. The iron employed in this case was rusty; but if it had been new, my father would in all probability have been the accidental author of the process which Professor Barff discovered ten years later. That consists in subjecting iron or steel articles to the action of superheated steam; and, when they are at a temperature sufficiently high, the following chemical change takes place: $3\ Fe + 4\ (H_2O) = Fe_3O_4 + 8\ H$. My father thought that what Professor Barff could effect with steam, he might also effect with air; and experiments were made varied both in character and results. On considering the fact that air is oxygen and nitrogen in mechanical combination only, I came to the conclusion, that, to form the lower or magnetic oxide, the quantity of free oxygen, and so of the air employed, must bear some proportion to the surface of the articles exposed to its action, more especially when a comparatively low heat is employed; and it has been found that the quantity of air passed through the retort during most of the unsuccessful experiments was three hundred or four hundred times more than was actually necessary. The mode of action I adopted was to admit a few cubic feet of air into the retort at the commencement of every half-hour, and then leave the iron and air to their own devices; the retort, of course, being tightly closed. During each half-hour a coating of magnetic oxide was formed, and the operation was repeated as often as was considered necessary. This was effective, but costly; both this and the Barff process requiring the external heating of the chamber. Successful experiments were made with air, but open to the same objection in regard to cost. Experiments with carbonic acid, produced by the decomposition of chalk, which should give $3\ Fe + 4\ (CO_2) = Fe_3O_4 + 4\ (CO)$, gave a coating of light color and easily removed; the film probably being a mixture of $Fe\,O$ and $Fe_3O_4$, or something nearer the metallic state than is magnetic oxide. But, even if successful, the cost of this method would still be too high. I therefore proposed to use a fuel gas-producer, similar in principle to the Siemens generator, but altered to suit other requirements; to burn the combustible gases thus produced, with a slight excess of air over and above that actually required for perfect combustion, and to heat and oxidize the iron articles placed in a suitable brick chamber by these products of combustion. I also arranged a continuous regenerator of fire-clay tubes underneath the furnace; so that the products of combustion, leaving the oxidizing chamber, passed outside the tubes, imparting a portion of the waste heat to them, which was taken up by the in-going cold air passing through their interior on its way to the combustion-chamber. I had hoped in this way to be able to so regulate the excess of air over that required for complete combustion, as to be able to produce magnetic oxide direct, instead of the lower and useless oxide or combination of oxides. I obtained some beautiful results, and some again were unaccountably bad; and I soon found that it was as difficult to regulate the precise amount of oxidation as it first was in the Bessemer process. But I was fortunate enough to hit upon an almost parallel remedy; that is to say, I increased the quantity of free oxygen mixed with the products of combustion, and oxidized the iron articles to excess during a fixed period of generally forty minutes, when magnetic oxide was found close to the iron, and sesquioxide over all. Then for twenty minutes I closed the air-inlet entirely, leaving the gas-valve open, and so reduced the outside coating of sesquioxide to magnetic oxide by the reducing action of the combustible gases alone.

The Barff patents have been purchased by my father. His process is better than ours for wrought iron, and perhaps for polished work of all kinds, as iron commences to decompose steam at a very low temperature, — in fact, much below visible redness. For ordinary cast iron, and especially that quality which contains much carbon, the Barff process is much too slow in its action; and some specimens that I have treated in England have taken as many as thirty-six hours to coat effectually, which could readily have been finished off in five hours by the Bower process. The main distinction between the two is, that the Bower is much more energetic in its action. The objection to the use of a closed muffle externally heated in the Barff process has been almost entirely overcome by simply putting wrought iron into a Bower furnace previously well heated, then shutting off both the gas and air supplies, and admitting steam into the regenerator tubes. Steel, I consider, can be equally well treated by both processes; except polished steel, which is better treated in a low-temperature Barff furnace. Of the fuel burnt in the gas-producers, a non-caking coal is the best. Virginian splint has suited very well in this country; and of this about one ton every three days is required for a furnace with an oxidizing chamber 13 feet long and 4 feet 3 inches wide and high. When a gas-coal is employed, it should be fed through the charging hoppers just before each deoxidizing operation, when a smoky flame is of great advantage. I have, however, discovered that anthracite coal can be used as well as a gas-coal by simply allowing petroleum to drop, at the rate of one gallon per hour, upon the red-hot surface of the coal in one of the producers. This method has been exclusively used in this country.

These magnetic-oxide processes not only protect from rust, but the coating is of such a beautiful color as to render articles ready for the market directly they are out of the furnace and cooled. One remarkable feature of these is, that there is no more cost (except in the labor of handling them) in treating 2,240 articles each weighing a pound than in coating a cube of the metal weighing a ton; and so penetrating is the process, that every crevice, no matter how intricate the pattern may be, is as effectively coated as the plainest surface. There is absolute certainty that paint used on iron so coated will adhere as well as on wood or stone; and thus iron may be used for construction work in a thousand directions in which it has not up to the present time been possible on account of its liability to rust, no matter what the coating used to protect it has been. Manufacturers appear far more ready to apply the processes here and on the continent of Europe than, up to now, they have been in England; but perhaps the reason has been, that, so far as Professor Barff's process is concerned, it has only just been shown how large masses can be dealt with by the use of the Bower furnace. For ordinary hollow-ware for kitchen or table use, whether of cast or wrought iron, the process is admirably adapted. It is intended to apply the process to cast-iron gas and water pipes; and, as the former have comparatively little pressure to bear, they may be made much lighter if rendered incorrodable: while, for water, there is no reason now why wrought-iron or mild steel pipes should not be used. In the case of railway-

sleepers in iron and steel, which are now almost wholly used in Germany, the process is likely to prove of much advantage. For fountains, railings, and all architectural work, the process is invaluable; and iron may now be used in many instances instead of bronze. The cost has been carefully estimated at two dollars per ton; and this may be reduced by giving several furnaces in charge of one workman, and by a better system of taking the articles out than that in use when the estimate was made. Tests have been made as to the effect of the process on the strength of the metals, with the result that no alteration was detected in the strength. Theoretically one would suppose that iron and steel would be somewhat toughened, as the tendency of the process is to anneal, and would, no doubt, if continued long enough, render some classes of cast-iron malleable. A very thin article, if excessively coated, might probably be weakened, due to the fact that the coat of magnetic oxide would form an appreciable percentage of the bulk of the article; but that, of course, is a very extreme case, and one which is not likely to ever occur in practice.

### Note on the jacketing of roasting cylinders at Deloro, Canada.

BY PROF. R. P. ROTHWELL OF NEW YORK.

The speaker said, that he merely desired to place on record the fact that he had been using roasting cylinders jacketed, to prevent any one from taking out a patent on the idea. He did not wish to deprive any one of the privilege of using it, but he also did not wish to be deprived of that privilege himself. In the roasting of arsenical sulphurets he had employed what is commonly known as the White and Howell cylinders, of plain boiler-iron, with fire-brick lining and shelves. He used two of them; the ore passing from one to the other through a pipe, without losing its heat. The first cylinder is 30 feet long and 5 feet in diameter, and takes out a large part of the arsenic and sulphur. The second is 24 feet long and a little less than 4 feet in diameter, in which the roast is finished. The two make a complete roast for chlorinating, and give from 94% to 98% of the gold. But these cylinders radiated an immense amount of heat, too much to allow the temperature to be kept sufficiently high to obtain a complete roast. This loss by radiation has been avoided by jacketing. A sheet-iron jacket is placed around the cylinder, leaving an air-space of two inches; outside of this is another jacket with a space of two and a half inches, which is filled with mineral or slag wool; this is mixed with plaster of paris, and further covered with roofing-paper bound on with wire. Immediately upon the use of this apparatus there was noticeable a tremendous reduction in the consumption of fuel required, and a remarkable increase in the amount of ore roasted. As thus made, it even resulted in heating the upper portion of the first cylinder too much, and roasting too quickly, not leaving in the ore the sulphur necessary for the treatment in the second cylinder. The trouble was remedied by removing eight feet of the jacket around the upper part of the cylinder.

### Geological relations of the topography of the South Appalachian plateau.

BY PROF. W. C. KERR OF WASHINGTON.

By aid of a rough black-board sketch of the Blue Ridge and Smoky Mountains, the backbone of the system, the speaker showed from a study of the rivers, that the plateau has been gradually travelling westward. A series of spurs are thrown out by the Blue Ridge on the east, making a drainage system of cross valleys; here are the head-waters of the Tennessee river, which force their way through the great escarpment of the plateau, and through the Smoky Mountains, which in some places attain an altitude of 6,000 feet. This is a very remarkable and curious fact. The cañon through which the waters break is 4,000 feet deep, and has rocky sides not easily removed or eroded. A study of the situation shows, that since the establishment of the water-system there has been slow and steady rise of the mountain chain, the waters at the same time cutting their way down. There is another curious feature in this connection: the Tennessee river runs between this chain and the Cumberland ridge, and it would naturally be supposed that there is a rise from the west side of the river to the Cumberland. But observations with the barometer show, that there is really a continuous descent from the top of the Smoky Mountains to the base of the Cumberland chain, and here we have a river running at a higher level than its tributaries. The explanation is simply, that the Cumberland ridge has been gradually sinking since the establishment of the water-system.

### The collection of flue-dust at Ems.

BY DR. T. EGLESTON OF NEW YORK.

In the treatment of silver from lead-ores, this subject is a matter of growing importance in Ems at the works under the charge of Herr Freidenbach, and of some importance here. In 1874 it was found at Ems that there was a considerable loss of product by the dry method, and the wet method was substituted; and still the loss of dust was much greater than had been supposed. There were three difficulties to overcome: to arrest the material carried off by mechanical means, to collect the material which is volatilized, — these two problems being comparatively easy of solution; but, when the collection was made, it was another thing to keep the material collected where it was, and prevent its further loss. The works are located on a plateau and hill. They run first down the valley, and then, turning on themselves, up the hill, continuing in a straight line to the top, where there is a chimney. In 1874 the length of the flue was 460 m., and it was furnished with the old style of condensing-chambers. The canal was then lengthened to 2,000 m., and carried to the flue 200 m. above the bed of the river. It was noted at once, that there was an immediate precipitation of flue-dust, much larger than had been anticipated, but still not effecting a sufficient reduction of the loss. An examination of the pipes led to the adoption of iron pipes, with the lower part terminating in zigzags 75 cm. deep, through which, by means of a door and close-fitting tube, the dust could be drawn out of the flue. This dust was rich, and the results of the method were satisfactory until the assays showed that much matter was lost by volatilization. Freidenbach soon found that the old-style arched flue was the worst that could be used; for, while its form gave strength to resist pressure from without, it also rendered it weak against pressure from within, and the gases found a comparatively easy means of exit through it. The flues were then made rectangular, bound together with iron, and made as tight as possible to prevent the escape of vapors. This form is now adopted everywhere. In the length of the flue was a series of condensation-chambers, but these were found to give no great results. The flue was now 2,600 m. in length, with an area of 42,650 □ m., and had cost 255,000 marks. A series of condensation-houses was built beyond the chimney,

and still the results were unsatisfactory. It gradually became apparent that what was wanted was surface, and not volume. The iron pipes before described not having been affected, there were introduced into the flue sheet-iron plates hung vertically. Four of these plates were at first put in; but the results were so immediate and so gratifying, that the number was increased to six, with still better effect. The conclusion was at once jumped at, that the flue would stand all the plates that could be put into it; and accordingly seventeen plates were introduced, having a space of 10 cm. between them. It was then discovered, that nearly all of the material carried off mechanically was thrown down near the furnace, and that volatilized was deposited a little farther on. These results having been reached, the difficulty was to keep these deposits where they were, and to prevent them from being carried off by the immense draught in so long a flue. This last obstacle was surmounted by placing transverse sheets of iron in the bottom. When the deposits reached a certain amount on the vertical plates, they dropped off from their own weight, and fell to the bottom, where the transverse plates retained them. Experiments were made as to the distance from the works at which the deposits were made; and at a short distance away was found nearly all the mechanical dust, that from volatilization being a little farther on. There was no material diminution in the draught occasioned by the introduction of the plates. The dust collected so quickly and to such an extent that it became a serious question as to how to remove it. The flues were constructed with manholes at the top, and the dust was in such fine state that the men would be subjected to the danger of suffocation. The problem was solved by setting fire to the flue and burning the dust, which was found in agglomerations easy to remove, and in just the condition to be put into the furnace. The removal was a matter of little difficulty, the manholes having been changed to the sides of the flue. Next arose the question of temperature, and whether or not the lowering of it had any effect on the collection of the dust. It varied from 300° C. near the chimney to 64° C. at some distance from it; and it was found that the degree of heat made little difference. This led to important conclusions; and the substitution was begun, near the chimney, of pasteboard for the iron plates. They answered the purpose just as well, provided they were of sufficient thickness to sustain themselves, and were also much cheaper. After the success of these experiments, the method of cleansing flues by water will probably be abandoned. They have demonstrated the importance of surface over volume, and of the rectangular against the arched flue. It is doubtful if any method can save the whole of the material carried off by mechanical means or volatilization; but it is proved that there can be saved two or three times more than was believed possible.

President Rothwell said that he had visited these works, and had taken much interest in going over them. By the process, a saving of about four per cent is effected over the old way; and Freidenbach charges a royalty of two per cent, or one-half of what he saves. Since the collection of the dust by burning, the pasteboard surfaces had been dispensed with, as they would be destroyed. He had closely observed the iron plates, and found that they were little affected. The first plates used were those which had been discarded from the screens, and had been lying about the yard, being as likely to be acted upon as any; but they showed no signs of deterioration. He had observed the same effect of surface in the collection of arsenic dust in the works at Deloro, although at times he had been obliged to use a fan to secure a draught in long flues. The fan, however, needs frequent cleaning. His observations in regard to the ability of the iron to withstand action by the vapors led him to believe that arsenical chambers might be constructed of the same material with advantage. In regard to the flues at Ems, he had the fault to find, that they were built partly beneath the ground, and were apt to become too warm. He was in favor of building them above ground, and on arched supports, which would give the additional advantage that they could be opened without stopping the run.

## Lines of weakness in cylinders.

BY PROF. R. H. RICHARDS OF BOSTON.

It has long been known to boiler-makers and to the users of cylindrical pipes of many kinds, that, when a tube is exposed to internal fluid pressure, the resolution of forces is such that the material of the walls of the tube is exposed to twice the stress in the direction tending to produce longitudinal rupture, that it is in the direction to produce circumferential fracture. By longitudinal fracture is meant the fracture by a rent parallel to the axis; by circumferential fracture, fracture by rents running round the cylinder. In consequence of this, makers of boilers always lay the fibre of their metal around the boiler; and the same is true with the makers of gun-barrels. I have never seen any good and simple illustration of this law until I met it in blowing glass. If a thin bubble of glass be blown out in a spherical form, and then exploded, it will be found that the particles tumble into totally irregular shapes, showing no special direction in the molecular structure of the material. If, now, a bubble of glass be blown out, and so manipulated that it will take a cylindrical form, and then be exploded, it will drop into ribbon-shaped pieces from end to end; and the only parts that will be found to differ from this form will be the two hemispherical ends, which will remain whole, having a fringe of ribbons representing the lines of fracture from the cylinder. The main point of difference between this experiment and the accidental explosion of large boilers appears to be, that in a boiler the shell goes at its weakest point, and once the rent is started it tears the boiler to pieces without much regularity of lines: while in the glass cylinder the walls are so nearly of the same strength that it can hardly be said to have a weakest point; when, therefore, it gets to its limit of strength, and is on the verge of exploding, there is no one place to initiate the explosion, and the glass explodes everywhere. This it does as it should do, by tearing into innumerable ribbons parallel to the axis of the cylinder. If $P =$ the pressure, and $D =$ the diameter of the cylinder, then $\frac{PD}{2} =$ stress tending to longitudinal rupture, and $\frac{PD}{4} =$ stress tending to circumferential rupture.

Professor Richards illustrated his statements by experiments with glass tubing and a blast, with the most complete success.

## The shop-treatment of structural steels.

BY MR. A. F. HILL OF NEW YORK.

The speaker urged the importance in the manufacturing-arts of a knowledge of the effects on iron and steel of the various processes to which those metals

are subjected. He took up these processes in their order, and gave the results of a close and careful study into the matter. In the operations of punching and shearing, it is conceded that the effect is to harden the metal to a local extent only; and also that enlargement of the area punched by reaming restores the plate to its original state. But Mr. Hill did not agree with Lieut. Barber, who has announced, as the result of his researches, that the amount of enlargement is a fixed quantity: on the contrary, the amount is dependent upon the carbon percentage and the thickness of the plate. The experiments were made with plates 18 inches wide, ¼, ⅜, and ½ inches in thickness, and .30, .40, and .50% carbon. They were cut in the planer, crosswise to the direction of the fibre; and three pieces from each plate were taken — one from the centre, and one from each end — for examination. The result of the experiments led to the conclusion, that the heavier the plate, or the lower the carbon percentage, the greater the effect of punching. Here is a clear indication of the direction which must be given to this line of investigation; but the conclusion is evident, that a restoration of strength is effected by reaming, although the enlargement is not a fixed quantity. In the cases of sheared and hammered open-hearth steel plates, annealing always restores the plate to its original strength. The capacity for welding is in inverse ratio to the carbon percentage, and the metal must not be heated any higher than is absolutely necessary to effect the weld. Annealing should immediately follow the welding, and the metal must be carried to a higher temperature than when it was last worked. It is a most important operation, and its effect varies directly with the carbon percentage. A metal bath gives unsatisfactory results: the best are obtained by annealing with oil. There is no more danger to be apprehended in annealing steel than in performing the same operation on iron; and nearly all trouble can be traced to poor workmanship.

## The strength of American woods.

BY PROF. S. P. SHARPLES OF CAMBRIDGE.

When Gen. Walker was put in charge of the Census department, he was authorized to appoint experts to inquire into special industries. Under this act Prof. Charles S. Sargent of Brookline was appointed to gather statistics in relation to forest industries. Soon after his appointment, in 1869, he became convinced that it would be desirable to make an examination of the fuel-value of the various woods of the United States; and this work was placed in my hands. At the same time I made the suggestion, that, while we had the opportunity, it would be well to test also the strength of these woods: the suggestion was at once adopted, and Professor Sargent immediately set his agents at work in various parts of the country to collect specimens of all the trees growing in their localities; employing, as a rule, botanists who were familiar with the flora of the region in which they were at work. The result was the collection of over 1,300 specimens of wood, comprising more than 400 species and varieties, nearly 100 of which had not before been described as trees growing in the United States. The ash and specific gravity of every specimen in this collection have been determined, in most cases in duplicate: there have been about 2,000 ash and 2,800 specific-gravity determinations. About 325 species were further tested for transverse strength and resistance to crushing. In these series about 1,300 specimens were tested; and, as each was tried in three different ways, it made in all about 3,900 tests. There was a total of about 10,600 tests made on the specimens, many of them being of a series that required at least ten entries on the final report. In addition, seventy tests were made of the carbon and hydrogen in a number of the specimens. These tests have already, so far as the results of the ash and specific gravity of the dry wood are concerned, been published (*Forestry bull.*, No. 32); and a bulletin is soon to be published giving the deflections under various loads.

After the wood had become thoroughly seasoned, it was dressed out into rods 4 centimetres square and 11 decimetres long. These were tested on the Watertown machine, the stick being placed in a perpendicular postion, resting on supports that were exactly one metre apart; the deflection being measured by an ordinary Brown and Sharp's scale graduated to millimetres. The force was applied at the centre of the length, by means of an iron bearing with a diameter of 12.5 millimetres. The loads were applied 50 kilogrammes at a time, and the deflection read on the scale after each weight was added. When the weight equalled 200 kilos, the load was taken off, and the set was measured; the load was again put on, the reading taken at 200 kilos, and again at every 50 kilos until the stick was broken, the breaking-weight being also noted. In entering the test, a record was made of the direction of the fibre in each piece, — i.e., whether the pressure was applied parallel with, or perpendicular to, the annual rings, or quartering them, — but this portion of the test resulted in a failure, the wood seeming to have equal strength in all directions of application of pressure. The stick was also weighed to about half a gramme, from which was calculated the specific gravity. To determine the specific gravity exactly, blocks were taken, carefully dressed out to precisely 11 centimetres in length and 35 millimetres square. They were carefully dried at the temperature of boiling water for a week, and were then measured with a micrometer caliper, and weighed; the specific gravity being calculated from the measurement and weight.

The ash was determined by igniting small blocks, thirty-five millimetres square and a centimetre long, dried in the same way, in a platinum dish in a muffle furnace heated by gas, the heat being applied so carefully that in most cases the ash retained the exact shape of the block: by taking care not to melt the ash, there was avoided a common error resulting from the non-combustion of a portion of the carbon. The ash was perfectly white, except where manganese or iron was present in the wood. It was judged best to report the ash exactly as found, and not to attempt any correction on account of carbon dioxide that might have been lost from the calcic carbonate present. From the results of the specific gravity and ash, the approximate full value was calculated. Count Rumford made experiments from which he came to the conclusion that the same weight of all woods will give the same amount of heat when burned under the same conditions; and Marcus Bull of Philadelphia, in 1826, reached the same result. These are the only attempts known to determine the fuel-value of wood. It is evident, that, if the cellulose in all woods is of equal value, that with the most ash is of the least value for fuel.

In 1848 Liebig made determinations of the carbon and hydrogen in the average composition of European woods; and, singularly enough, all of his experiments were made on hard wood, with one exception, that of fir. I determined the carbon and hydrogen in forty specimens of hard, and twenty-nine specimens of soft, wood. The average results agreed

within one-tenth of one per cent with those of Liebig: in soft woods the hydrogen is almost the same as in hard, but the carbon is from 4 to 5% greater, giving pine a higher fuel-value than hard wood. In these values we find mountain mahogany at the top (on account of its weight); the southern long-leaved pine is next, and at the bottom is poplar; shell-bark hickory is third on the list, these three having 49 to 54% of carbon. The pines are very close together, with over 52% of carbon, while the hard woods average a little under 49% of the average fuel-value by weight for soft wood: burning one kilo gives 4,488 units of heat; hard wood, 3,993.9: by volume, soft, 2,524; hard, 2,776.

In the tests for breaking-strength, the coefficient of elasticity was calculated for all sticks for the first two deflections, i.e., at loads of 50 and 100 kilos, and that at 100 kilos was found in many cases to be larger than that at the lesser load; but the explanation is found in the fact that there is more or less twist in the stick, no matter how carefully it is dressed; and this twist is increased by seasoning. The first load of 50 kilos is just about sufficient to take out the twist, and the second represents the true deflection. The results have shown, that it is by no means necessary to break two sticks to show which is the stronger, provided they are of the same kind of wood: the weak stick will show the largest deflection from the start. The strongest stick found was a piece of common yellow locust, the average of eight or nine specimens giving a breaking-weight of 543 kilos; hickory and southern pine follow closely; ash was found to stand very well up to a certain point, and then it gives way suddenly and without warning, generally shattering badly; California red-wood shatters thoroughly when it breaks, and shows the effect all over, rendering the entire stick worthless; white oak is inferior to several other oaks and to southern pine, the average breaking-weight of 40 specimens being 386 kilos, while the average of 8 specimens of the southern low oak was 528 kilos; 27 specimens of southern pine gave 490 kilos; 36 specimens of the Douglas fir from the Pacific coast, 374 kilos; 6 specimens of western larch, 523 kilos; 13 specimens of white pine, 274 kilos; 11 specimens of beech, 454 kilos; 16 specimens of large nut shell-bark hickory, 464 kilos; 20 specimens of white hickory, 512 kilos; 24 specimens of white ash, 378 kilos; 8 specimens of locust, 543 kilos.

The next series of tests were made on specimens of the same-sized square as before, and 32 centimetres long, compressing them in the direction of their fibres. Nine specimens of locust stood an average weight of 11,206 kilos; 5 specimens of western larch, 10,660 kilos; 35 specimens of white oak, 8,183 kilos; 24 specimens of southern pine, 10,498 kilos. The effect of the pressure on the specimens was very curious. Professor Sharples exhibited a number of specimens thus treated, which showed curious changes under the pressure.

The third series of tests was to find the force necessary to indent the wood at right angles to the grain. These are not yet finished, and I can give only a few general results. The load was noted at every one-hundredth of an inch of indentation, and it was found that the first one-hundredth was the hardest to make. After that the amount of force necessary diminished with each one-hundredth, until, at one-tenth of an inch indentation, it was found that the force required was only twice that at one one-hundredth. The specimens were often destroyed, however, before reaching the greater depth. In closing this paper, I wish to express my public thanks to Col. Laidley for many valuable suggestions made during the work, and to Mr. Howard for his careful aid in bringing the tests to a successful issue.

## The eozoic and lower paleozoic in South Wales, and their comparison with their Appalachian analogues.

BY DR. PERSIFOR FRAZER OF PHILADELPHIA.

This paper embodied the observations of the author at St. David's, South Wales, during a visit at the invitation of Prof. Archibald Geikie, director-general of the geological surveys of Great Britain and Ireland, and Mr. B. N. Peach, geologist in charge of the survey of Scotland. The occasion offered a rare opportunity for studying those classic rocks, — the Cambrian; but there were other series of rocks exposed of the greatest interest to the student of Appalachian geology, not only from their points of resemblance to other rocks met with frequently on the Atlantic border of the United States, but from the similar relations which they seemed to bear to the measures in contact with them. At Roch's Castle is an area of Llandeilo flags, resembling what Dr. Frazer has often designated as argillaceous shale; and, in specimens where the decomposition into clay had proceeded very far, there was almost invariably the same disposition to split into prisms of unequally large pairs of parallel planes, no two of which were perpendicular to each other, giving them a remote resemblance to some of the indefinitely numerous varieties of triclinic crystals. Like similar argillaceous shales and slates near the town of York, Penn., and elsewhere in America, the slabs split up into almost any desired degree of thinness. The rock on which the castle is built is a silicious, greenish rock, showing everywhere included crystals of more or less definite outline, and generally of about the size of a buckshot, and containing a whitish or yellowish feldspar. The analogy between this rock and the 'jaspers' of Rogers, of which Dr. T. Sterry Hunt was the first to point out the real character, is striking. In the porphyry of Roch's Castle, the feldspar is oftener yellowish-green than in the orthofelsite porphyries of the South Mountain and of the eastern United States, as there is much of the Welsh orthofelsite which shows flesh-colored feldspar, and much of that of the South Mountain which exhibits green and other colors. The lamination and flaggy structure, when it was apparent, seemed to be entirely due to the arrangement of the cleavage surfaces of numbers of small crystals in the same plane; because a large part of the rocks defied all attempts to define sedimentary structure. Similiar exhibitions of orthofelsite are found in quantity on the eastern slope of the South Mountain in Pennsylvania, from Dilsburg to Monterey. In the latter regions, however, the beds, which are generally in contact with them, have a more chloritic and a more schistose character than the Llandeilo flags. They are marked, too, in America, for a part of their extent, by an horizon of copper ores, of which no trace was observed in South Wales. To the west and north of the beds of intrusive rock which seem to underlie St. David's, and in the harbor of Porth Ceri, there occurs a thick series of greenish, arenaceous beds, showing numerous streaks of chlorite. They are of very great interest, because they are unmistakably hydro-mica schists of light greenish or grayish color, very finely laminated, and resembling the rocks of parts of the South Valley Hill, and of parts of Fultòn and Manor townships on the Susquehanna river. Similar schists, which (according to the writer's theory of structure, based on

the study of south-east Pennsylvania) are associated with distinctively chlorite schists, are in contact with the orthofelsite of the South Mountain, in Adams and York counties, Penn. Very similar schists may also be met (though in this case without the presence of orthofelsite) in the Chestnut-hill ore-banks, just north of the town of Columbia, on the lower Susquehanna, and in the Grubb ore-bank, Hellam township, York county. Parts of these rocks in Porth Ceri are very hard, and resemble strikingly some of the greenish grits on the left bank of the Susquehanna, near the Maryland line. These beds on their exposed surfaces become more and more distinct from each other in color as their disintegration proceeds; and it is impossible to overlook the analogies which even these physical features present to the variegated clays, chiefly red and white and pink, which border the bases of the South Mountain, both on the east and in the Cumberland Valley, in Pennsylvania. Another paragenesis, strikingly analogous to that in the South Mountain, is found at Trelethyn, about one mile west by north of St. David's, near one of the largest bands of 'greenstone,' which are colored as such on the geological map. Here is a hard, silicious, greenish rock, with interstitial spaces, filled with milk quartz and epidote, the latter in large excess. This mixed rock, as is the case very frequently in Pennsylvania, forms low ridges in the midst of the softer chloritic schists and orthofelsites, with which it is almost always closely associated. About a mile west by south of St. David's is a hummock, pronounced to be a porphyritic lava, and which greatly resembles the hard green silicious rock, which occurs near Williamson's Point, on the left bank of the lower Susquehanna, near the Maryland line. It is a very important point in the proper understanding of the structure here, and its analogy with the Appalachian phenomena, to determine whether the band of schists which intervene between the two belts of intrusive beds be really Cambrian, or whether they may not correspond with the horizon, to which Dr. Hunt and the writer have supposed that the enormous masses of crystalline schists which stretch from Vermont to Georgia belong. On this point the writer feels unwilling to differ with the able geologists who have assigned their position to the English schists, without attaining, at least, to a portion of their information and experience of this terrain. It is certain that if they be in reality Cambrian, there are great difficulties in the way of considering the orthofelsite beds to the north-west as forming a part of the Huronian. Dr. Frazer studied carefully the structure, with especial reference to the mooted questions connected with the age of the syenitic granite passing through St. David's; and from the appearances of injection of syenitic matter into the elastic beds of the Cambrian shales, regarded the conclusion as unavoidable, that the whole of the syenitic granite mass, of which a part forms the foundation of south-eastern St. David's, is younger than the schists which lie to the south-east of it. If this be so, there is good reason for ascribing the rocks to the north-west of this granite belt to the same age, and of explaining their somewhat modified lithological characters to the alteration produced by this large igneous mass. In summing up his impressions, Dr. Frazer said, —

1. There is a striking analogy between some of the beds which constitute the lower Cambrian in South Wales, and some of the beds which constitute the horizons proximate (both above and below) to the primal of Rogers, or the Potsdam of the New-York geologists. These analogies are not confined to kinds of rocks, but embrace paragenesis, topography, and accessory mineral contents.

2. There is a strking analogy between the orthofelsites, ash-beds, syenitic granites, diabases which here seem to be *younger* than the above, and the same rocks which in the Appalachian region of America seem to be *older* than the primal.

According to the current views of the English geologists, the entire coast-line, which forms the subject of these notes, is minced up by faults of different extents and directions. The writer was not able to convince himself of the existence of all of these faults, nor has he ever seen so many together. At the same time he does not wish to compare on equal terms the experience gained in his short visit with the greater experience of his hosts. Still, he cannot accept the view of so many faults; and mainly on this account he believes the study of the structure in South Wales to be especially important to American geologists, although it seems to support a view of the age of orthofelsites and crystalline rocks in South Wales which the author has always combated, and still combats, as inapplicable to the eastern United States. If, however, there were a network of faults, such as has been stated, the attempts to present a theory of superposition would be attended with the greatest difficulties, and, with no more investigation than he has had opportunity to make, would be entirely fruitless.

### The business meeting.

Dr. Thomas M. Drown, the secretary, presented the report of the council, from which it appeared that the receipts of the institute for the year had been $13,169.05, and the expenses $8,140.53; leaving a balance of $5,028.52, which will be invested by the council. The receipts were much higher than in the previous year, the result of a large increase in membership. The tenth volume of the proceedings has been issued, and there will soon be published an index of all the volumes thus far published. Regular meetings were held at Washington and Denver, at which it was gratifying to note the large increase of papers on the mining and treatment of the ores of the precious metals. During the year 10 members have resigned, 25 have been dropped for non-payment of dues, and 8 have died, leaving the present membership at 1,213; of these, 5 are honorary, 50 foreign, and 149 associate members.

The following-named gentlemen were elected officers for the ensuing year: president, Robert W. Hunt, Troy, N.Y.; vice-presidents (for two years), S. F. Emmons, Denver, Col.; W. C. Kerr, Washington, D.C.; S. T. Wellman, Cleveland, O.; managers (for three years), John Birkinbine, Philadelphia, Penn.; Stuart M. Buck, Coalburgh, Kanawha County, W. Va.; E. S. Moffat, Scranton, Penn.; treasurer, Theodore D. Rand, Philadelphia; secretary, Thomas M. Drown, Easton, Penn.

The following papers were read by title only: Gas-producer explosions, by P. Barnes, Elgin, Ill.; Ice mining and storing, by Prof. W. P. Blake, New Haven, Conn.; The mining region about Prescott, Arizona, by John F. Blandy, Prescott; Blast-furnace practice, by Casimir Constable, New York, N.Y.; Notes on the geology of Egypt, with especial reference to the rocks from which the obelisks have been taken, by Dr. Persifor Frazer of Philadelphia, Penn.; Notes on a protected iron hot-blast stove, by Frank Firmstone, Easton, Penn.; The geology of Cape Hatteras and the south Atlantic coast, by Prof. W. C. Kerr, Washington, D.C.; The divining-rod, by Dr. R. W. Raymond, New York, N.Y.; Notes on the Linkenbach

improvements in ore-dressing machinery used at Ems, by R. P. Rothwell, New York, N.Y.; Determination of manganese in spiegel, by G. C. Stone, Newark, N.J.; Gas analysis, by Magnus Troilius, Philadelphia, Penn.; Determination of copper in steel, by Magnus Troilius; History and statistics of the manufacture of coke, by J. D. Weeks, Pittsburg, Penn.; Notes on settling-tanks in silver-mills, by Albert Williams, jun., Washington, D.C.; Water-gas as a fuel, by W. A. Goodyear, New Haven, Conn.; The occurrence of gold in Williamson county, Texas, by Prof. C. A. Schaeffer, Ithaca, N.Y.; On the utility of the method adopted by the Pennsylvania geological survey of the anthracite fields, by B. S. Lyman, Northampton, Mass.; A new form of hydraulic separation for the mills of Lake Superior, by Prof. R. H. Richards, Boston, Mass.; An accident resulting from the use of blast-furnace slag-wool, by Prof. T. Egleston, New York, N.Y.

On motion of Mr. Bayles of New York, a proposed amendment to rule 6, requiring an additional regular meeting during the year, was laid on the table.

On motion of the same gentleman, a suitable vote of thanks was passed to all the gentlemen in Boston who had put the members of the institute under obligations; and, after a formal surrendering of his charge by the retiring president, Mr. Rothwell, the meeting was adjourned.

---

## *SIR CHARLES LYELL.*[1]

### II.

WHEN he returned from this journey, he entered Lincoln's Inn, and began a rather desultory life in the law; and for the five subsequent years his geology had little growth save in his holiday-time. But his eyes, weak from childhood, gave him more trouble as years went on. He found the studies little to his taste, and each vacation drew him more and more strongly to science. In 1823 he became secretary of the geological society. This seems to mark the turning-point in his career; for, though he nominally kept his place as a student for the bar, we find him more and more separated from it in interest. In this year he published his first geological paper.

Perhaps the most interesting part of his letters, at least to the general reader, are those to his father from Paris in 1823. He had an easy entrance to the society of that day, and his clear pictures of many of the scientific men are extremely entertaining. Humboldt, Cuvier, La Place, Broquiert, C. Prévost, Tromsoe, all came under his trenchant pen. Of these Constant Prévost was doubtless his most effective teacher; for his was a spirit of singular insight, and the lines of his thought somewhat resembled those of Lyell's own mind. He has left a scanty record in his writings, but his power is marked in his effect on all who came within his influence.

In 1825, at his father's request, he once again went about his law; was called, and for two years rode circuit with his mind on older, if less musty, things than Jarndyce *vs.* Jarndyce, and the like. This seems to have been the last chance the law had of winning a very keen intelligence to its fields: henceforth he seems to have left it altogether. In 1828 his Principles of geology first took definite shape in his mind, and until his first edition in 1830 he was busied in many journeys after facts for his work. Central France, Italy, Spain, and Germany gave him the most of his field-matter; endless talks with the workers of those countries, for which his considerable knowledge of modern languages well fitted him, did the rest. In these and other journeys, his letters and journals show his ready understanding of men and their societies. He was never a solitary worker: almost every thing comes out in talks and work with others. Even his journals are always addressed to some one. It was an admirable feature of his character, that he was generally out of himself, and even his antagonisms are sympathetic.

His southern journey carried him to Sicily; but it is curious to note that he was delayed in Naples by need of care in avoiding the Tripolitan pirates, by a steamship-journey. It seems strange, that, in the days of emancipation of British slaves, with all the navies of Europe free from larger calls to action, this nest of pirates should have been tolerated.

In 1831 he was appointed professor of geology in King's College, London. His nomination had to be confirmed by a board of bishops and other church-magnates; and his open opposition to the notion of a deluge and a seven-days' creation made it doubtful if he would receive it. At last, in a fine English way, they declared "that they considered some of my doctrines startling enough, but could not find that they were come by otherwise than in a straightforward manner, and logically deducible from the facts; so that, whether the facts were true or otherwise, there was no reason to infer that I had made my theory from any hostile view towards revelation."

His experience as a lecturer in Kings College was not such as to procure him much profit or intellectual gain: so, though he deemed his work successful, he soon abandoned it.

[1] Continued from No. 3.

In 1832 he married Miss Horner, daughter of Leonard Horner, one of the best of the geologists of that day. It was a singularly fortunate union, that lasted for more than forty years. In all his subsequent work his devoted wife had a large share of sympathy, and often no small part of actual labor; while, by her rare graces of person and intellect, she made his home more of an intellectual centre than any other of its day in England.

In 1834 he made a careful journey through Denmark and Sweden, to study the phenomena of elevation and subsidence exhibited along their shores. His journals in this expedition show in an admirable way the power of combining rapid travel with clear seeing, that so marked his journeys.

We cannot follow the interesting story of his other journeys on the continent. They were all undertaken with the view of fixing the data for his 'Principles.' There are few books covering so wide a field that has been so patiently, so devotedly labored.

In the summer of 1841 Lyell made his first journey in the United States. He was specially induced to the journey by the offer of a course of lectures in the Lowell institute, a prize that has tempted so many distinguished men to this country. When the history of science in America comes to be written, this institution will have to be credited with much of the best help that has been given to its advancement. Thirteen months of assiduous travel carried him over a large part of the United States and Canada.[1] It is to be regretted that only half a dozen letters touch upon this interesting journey, for they show a singularly clear and just impression of the social conditions of that time. It is curious to notice, that, in the first letter, he indicates his half belief that the negroes should be distinguished as a distinct species from the Caucasian. In these letters as well as in the record of his travels, in the First visit to the United States, he shows always a sense of hopefulness for our future, and delight in our essential, though rather material, success, that is in wide contrast with the other travellers of that day. In the letter to George Ticknor, Esq., written just after his return to Great Britain, he shows a capital power of discrimination between the good and the evil of our land at that time. These letters to Mr. Ticknor are among the most charming in the second volume, showing him at his best; for his correspondent had the admirable power of putting all men to their best in their intercourse with him.

[1] Travels in North America, with geological observations. 2 vol., London, 1845.

In 1845 we find him, with Faraday, a member of a commission on colliery-explosions. His picture of Faraday is very interesting, and shows a new side of that remarkable character.

In 1845 he again visited the United States, remaining nine months. In this journey he saw the south once again, and found himself much more content with the institution of slavery; for he now saw how much it had done for the people not born in its toils. Unhappily, his letters are not sufficiently numerous to follow him on his geological work: the reader may, however, do this in his Second visit to the United States.[1] He made two other visits to this country, both much briefer than his earlier journeys. One of them was for a general and very successful series of lectures before the Lowell institute; and the last as commissioner to the "world's fair" of New York, of 1853. In 1854 he visited Madeira, the last, and on some accounts one of the most important, of his many journeys; for it completed his admirable studies of volcanoes. From this time on, his work was mainly given to the successive editions of his Manual and Principles, and the Antiquity of man, no memoirs of importance appearing from his pen. To this task of re-editing he added that of adviser to all the rising geologists of England, we may say of the world. His house, at 15 Harley Street, famous in an earlier day as the home of Sir Arthur Wellesley, became the centre of a brilliant society; and in its kindly offices his beautiful life went slowly to its end. In the spring of 1873 his wife died. He struggled bravely against the burden of time and care for nearly two years, until, on Feb. 22, 1875, he passed away; leaving one of the purest memories that was ever gathered in a life of nearly fourscore years, and a place among the students of the earth's structure that can never be filled.

It remains to speak of the work of the editor. This seems remarkably well done. A small and well-considered thread of narrative binds the scattered letters and fragmentary journals into a whole. We see the man, unconsciously pictured by himself, from his youth to his end. An excellent list of his contributions to science accompanies the work.

It is to be regretted that the letters are not twice as numerous. There are none to C. Prévost or to Deshayes, and scarcely any to

[1] A second visit to the United States of North America. 2 vol., London, 1849.

his other continental correspondents. There are none to Agassiz, with whom he was in correspondence. It is to be hoped that in another edition some of these omissions may be supplied. They afford the best keys to the history of scientific opinions in the vigorous years of this century that have yet been given to us. Unfortunately, the most instructive part of his intercourse, that with his companions in his own society, did not, of course, find this form of expression; but there is enough in these two volumes to show the peculiar charm of his character and to explain his wide influence. It has been the good fortune of the writer to use the Principles for nearly twenty years as a 'compend' for lectures to a class of university students. The beauty of their spirit has served to enchain near a thousand students in the study of the science, while the recollection of instructive days with their author has freshened the labor of teaching. His was a pure, strong spirit, well pictured in his own charming account of the spirit of man, as free: —

"ire per omnes
Terrasque tractusque maris coelumque profundum."

## ASTRONOMICAL LITERATURE.

*Bibliographie générale de l'astronomie, ou Catalogue méthodique des ouvrages, des mémoires et des observations astronomiques, publiés depuis l'origine de l'imprimerie jusqu'en 1880.* Par J. C. HOUZEAU et A. LANCASTER. Tome Second: *Mémoires et notices insérés dans les collections académiques et les revues.* 1er fascicule, déc., 1880; 2e fasc., mars, 1881; 3e fasc., juin, 1881; 4e fasc., avril, 1882. Introduction, (?), 1882 [the whole volume consisting of 2,225 col., or about 1,100 p.]. l. 8°.

BEFORE the publication of this work, there were three general scientific bibliographies of importance to astronomers, — Reuss' Repertorium, the Royal society's Catalogue of scientific papers, and Poggendorff's Handwörterbuch. The first two related only to memoirs, and not to separate books: the third included the most important books and memoirs of each author. Reuss (vol. v., Astronomy) was very far from complete to 1800; the Royal society's catalogue omitted whole series of journals from its plan, so that the work of MM. Houzeau and Lancaster has over forty per cent more entries for the corresponding period. Poggendorff's excellent work will always be useful. Of special astronomical bibliographies there are several; the two most important being Lalande's and the Catalogus librorum of the Pulkova observatory. These will always have a peculiar value; but for practical purposes these and almost all other special bibliographies will be superseded as soon as M. Houzeau's work is completed.

Vol. ii. (the only one yet published) consists of references to all memoirs, etc., in the transactions of learned societies and in journals. These are classified by subjects, — somewhat minutely, as may be seen by the following extract, which contains all the divisions of celestial mechanics: —

SECTION V. — *Mécanique céleste.*

| SECT. | | PAGE. |
|---|---|---|
| 1. | L'attraction en général, sa cause; le mouvement d'un corps sous son influence | 527 |
| 2. | Théorie générale des perturbations | 539 |
| 3. | Perturbations principales des grandes planètes | 564 |
| 4. | Théorie des satellites | 569 |
| 5. | Variations séculaires des orbites des planètes | 572 |
| 6. | Masses des planètes | 578 |
| 7. | Stabilité du système planétaire | 579 |
| 8. | Théorie de la lune | 582 |
| 9. | Attraction des sphéroïdes | 599 |
| 10. | Rotation et figure des planètes et de leurs atmosphères | 608 |
| 11. | Théorie de la précession et de la nutation | 622 |
| 12. | Théorie de la libration de la lune | 625 |
| 13. | Théorie des marées | 626 |
| 14. | La marée et le rotation du globe | 634 |

The authors have added to very many of the references a brief note of the contents of the paper. These notes will often appear too brief and inexact to the specialist in each department (who will, however, be grateful for them when he is looking up some unfamiliar subject), and it would not be hard to find some misconceptions recorded in them; but they double the value of the book to the working astronomer, and are priceless to the pupil.

The best indication of the way in which the work is done is to be had by quoting one or two extracts at random: —

"BAILY (F.): On a remarkable phenomenon that occurs in total and annular eclipses of the sun. Londres, MAS., X, 1838, 1. [etc.] Les grains blancs, le peigne et la goutte noire."

"WURM: Merkur. Ba J, Sup, II, 1795, 4. Diam. apparent."

"SECCHI, A. Saturne, Le soleil, [etc.] p. 395, avec 1 dessin, p. 255."

It may be noted here, that there are only some score of drawings of Saturn referred to: the list might be trebled easily. The registers of authors, etc., are most full and valuable; and every aid is provided for a quick consultation of the authorities.

It has been considered necessary to limit the scope of the work to astronomy proper, and sometimes this limitation is quite inconvenient. For example: measures or computations of the compression of the earth deter-

mined by geodetic methods have been excluded (and also measures of arcs of the meridian, length of seconds-pendulum, etc.), while only those determinations which are astronomical in their essence are given.

In some cases this produces strange lacks, yet it is probable that no better plan could have been chosen. Even in bibliography it is necessary to stop somewhere.

The introduction, of eighty-nine pages, is the most generally interesting portion of the work, as the statistics of astronomical bibliography (only of memoirs, etc., not books, be it remembered) are here discussed.

Some thirty thousand original articles are referred to in this volume. Leaving out the unimportant ones, the rest are divided as to language as follows: —

| | | | |
|---|---|---|---|
| French | 5,991 | Dutch | 85 |
| English | 5,809 | Danish | 39 |
| German | 4,438 | Spanish | 29 |
| Italian | 791 | Portuguese | 29 |
| Latin | 547 | Polish | 7 |
| Swedish | 118 | Bohemian | 6 |
| Russian | 89 | Hungarian | 6 |

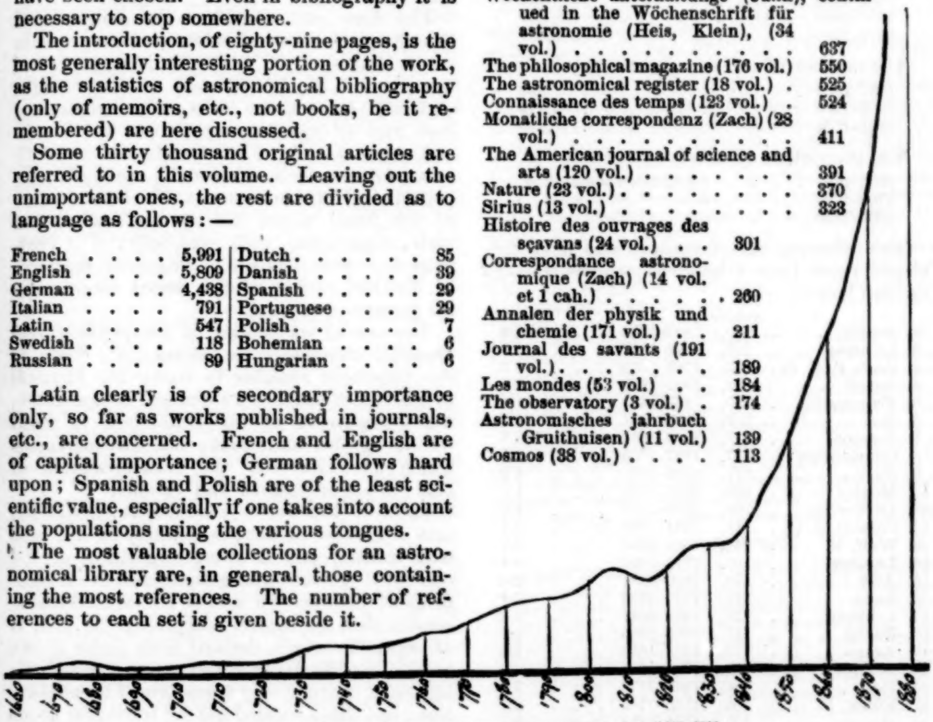
Latin clearly is of secondary importance only, so far as works published in journals, etc., are concerned. French and English are of capital importance; German follows hard upon; Spanish and Polish are of the least scientific value, especially if one takes into account the populations using the various tongues.

The most valuable collections for an astronomical library are, in general, those containing the most references. The number of references to each set is given beside it.

| | |
|---|---|
| Monthly notices of the royal astronomical society (40 vol.) | 1,573 |
| Comptes-rendus de l'académie des sciences de Paris (93 vol.) | 1,481 |
| Histoire de l'académie des sciences de Paris (107 vol.) | 779 |
| Philosophical transactions of the royal society of London (169 vol.) | 551 |
| Memoirs of the royal astronomical society (45 vol.) | 309 |
| Proceedings of the royal society of London (28 vol.) | 222 |
| Reports of the British association for the advancement of science (47 vol.) | 203 |
| The selenographical journal (3 vol.) Vierteljahrsschrift der astronomischen gesellschaft (14 vol.) | 147 |
| Bulletins de l'académie des sciences de Belgique (72 vol.) | 139 |
| Bibliographie astronomique, Lalande (1 vol.) | 119 |

Annuals, reviews, and journals, which have furnished more than a hundred articles, follow in the order of importance: —

| | |
|---|---|
| Astronomische nachrichten (99 vol.) | 1,918 |
| Berliner astronomisches jahrbuch (107 vol.) | 896 |
| English mechanic and world of science (32 vol.) | 841 |
| Wöchentliche unterhaltunge (Jahn), continued in the Wöchenschrift für astronomie (Heis, Klein), (34 vol.) | 637 |
| The philosophical magazine (176 vol.) | 550 |
| The astronomical register (18 vol.) | 525 |
| Connaissance des temps (123 vol.) | 524 |
| Monatliche correspondenz (Zach) (28 vol.) | 411 |
| The American journal of science and arts (120 vol.) | 391 |
| Nature (23 vol.) | 370 |
| Sirius (13 vol.) | 323 |
| Histoire des ouvrages des sçavans (24 vol.) | 301 |
| Correspondance astronomique (Zach) (14 vol. et 1 cah.) | 260 |
| Annalen der physik und chemie (171 vol.) | 211 |
| Journal des savants (191 vol.) | 189 |
| Les mondes (53 vol.) | 184 |
| The observatory (3 vol.) | 174 |
| Astronomisches jahrbuch Gruithuisen) (11 vol.) | 139 |
| Cosmos (38 vol.) | 113 |




CURVE OF FREQUENCY OF ASTRONOMICAL PUBLICATIONS, A.D. 1660-1880.

The number of articles published per decade from 1601 to 1880 is as follows: —

| | | | |
|---|---|---|---|
| 1601–1610 | 5 | 1741–1750 | 241 |
| 1611–1620 | 4 | 1751–1760 | 311 |
| 1621–1630 | 4 | 1761–1770 | 372 |
| 1631–1640 | 6 | 1771–1780 | 557 |
| 1641–1650 | 15 | 1781–1790 | 669 |
| 1651–1660 | 17 | 1791–1800 | 712 |
| 1661–1670 | 72 | 1801–1810 | 979 |
| 1671–1680 | 128 | 1811–1820 | 865 |
| 1681–1690 | 71 | 1821–1830 | 1,188 |
| 1691–1700 | 74 | 1831–1840 | 1,234 |
| 1701–1710 | 115 | 1841–1850 | 1,782 |
| 1711–1720 | 108 | 1851–1860 | 2,712 |
| 1721–1730 | 139 | 1861–1870 | 3,838 |
| 1731–1740 | 255 | 1871–1880 | 6,372 |

This is a condensation of a more extended table (by years), which is better exhibited in

the accompanying figure of the curve of frequency of astronomical publications. Notice in the curve the dates of the discovery of Neptune (1846), of the transit of Venus (1874), of the French Revolution (1794), of the wars of Napoleon (1815), etc.

The number of authors per century is: —

| | |
|---|---|
| 1601-1700 | 88 |
| 1701-1800 | 571 |
| 1801-1880 | 2,901 |

The number of articles per century is: —

| | |
|---|---|
| 1601-1700 | 396 |
| 1701-1800 | 3,479 |
| 1801-1880 | 18,970 |

The proportion of articles per author is: —

| | |
|---|---|
| 1600-1699 | 4.5 articles per author. |
| 1700-1799 | 6.1 " " " |
| 1800-1880 | 6.6 " " " |

The following list of authors who have furnished more than a hundred articles conveys its own lessons: —

| | Articles. | | Per year. |
|---|---|---|---|
| 1. Secchi | 360, | 1846-1878 | 10.9 |
| 2. Lalande | 299, | 1743-1807 | 4.6 |
| 3. Zach, F. X. de | 252, | 1785-1832 | 5.3 |
| 4. Bessel | 243, | 1805-1846 | 5.8 |
| 5. Flammarion | 210, | 1863-1881 | 11.1 |
| 6. Birt | 207, | 1857-1881 | 8.3 |
| 7. Proctor | 178, | 1865-1881 | 10.5 |
| 8. Gruithuisen | 177, | 1817-1850 | 5.2 |
| 9. Faye | 177, | 1846-1881 | 4.9 |
| 10. Mädler | 169, | 1831-1870 | 4.2 |
| 11. Le Verrier | 164, | 1839-1877 | 4.2 |
| 12. Cassini, J. D. | 143, | 1664-1709 | 3.1 |
| 13. Wolf, R. | 142, | 1844-1881 | 3.7 |
| 14. Laplace | 135, | 1772-1827 | 2.4 |
| 15. Airy | 134, | 1826-1881 | 2.4 |
| 16. Bode | 124, | 1775-1826 | 2.4 |
| 17. Lockyer | 120, | 1864-1881 | 6.7 |
| 18. Encke | 117, | 1819-1865 | 2.5 |
| 19. Arago | 110, | 1814-1853 | 2.8 |
| 20. Delambre | 107, | 1783-1822 | 2.7 |
| 21. Heis | 106, | 1847-1877 | 3.4 |
| 22. Euler, L. | 105, | 1735-1783 | 2.1 |
| 23. Hansen | 105, | 1824-1874 | 2.1 |

It will be evident that this book is indispensable to every astronomical library; and the smaller the library, the more important such a work becomes. Much of the material of this work has been incorporated in another work by M. Houzeau: Vade-mecum de l'astronome, Brussels, 1882; 28+1,144 p. 8vo.

For each of these works, astronomy and every astronomer owes a debt of gratitude.

EDWARD S. HOLDEN.

## THE FORMATION OF COAL.

*Mémoire sur la formation de la houille;* par Grand'-Eury. Paris, *Dunod.* 1882. 196 p., 4 pl. 8°.

THIS work of Grand'Eury, reprinted from the *Annales des mines* for 1882, exposes upon the origin of the coal such an array of facts, considerations, hypothetical subjects of inquiries, and assertions based upon long and careful researches, and these are scattered in so many chapters, that the only possible way to give an idea of the scope of the work is to quote the titles of the essential divisions.

The first part considers the botany and stratigraphy of the carboniferous formations, in seven chapters: 1°. State of disintegration of the plants; 2°. Distribution of the remains of fossil plants in the rocks; 3°. Structure of coal, and its organic composition; 4°. Trunks and stipes *in situ;* fossil forests and carboniferous forests, their relation to coal-beds; topographical circumstances; 5°. Examination of the fossil stems and of the lignite, and their comparison with coal-beds; 6°. Peat-bogs and other deposits of vegetable matters; 7°. Critical review of the divers theories on the formation of coal.

The second part treats of the physical and chemical characters as follows: 1°. State of the vegetable remains in coal; 2°. Physical properties of coal; 3°. Chemical composition; 4°. Comparison of the characters of fossil wood, lignite, and peat; 5°. Circumstances which have fostered the transformation of coal; 6°. Conclusions and *résumé.*

Each of the above chapters is subdivided into a number of sections, ninety in all, each with a title, and a short exposition of the contents. From his long researches in the coal-fields of Europe, the author comes to the conclusion that the matter composing the coal is of vegetable origin, derived from plants grown *in situ*, rapidly decomposed under atmospheric influence, more slowly transformed by maceration, and later washed out by torrential floods of rain, transported and deposited in depressions or basins surrounded by swampy forests, — the coal, in his opinion, being the result of stratification like the rocks. Besides the many other objections which could be made against this theory (a theory suggested to the author by the small areal surface occupied by the coal-deposits of France) we may mention the wide extent of the American coal-fields, and the continuity of some of the beds which cover areas of many hundred square miles, as sufficient to contradict the assertions of the distinguished author. Nevertheless, the book is very instructive as exposing a mass of facts concerning the divers phases of a formation, which, though often considered by science, are still, some of them at least, unexplained.

# WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

## ASTRONOMY.

**The great comet of 1882.** — Mr. R. H. Tucker, jun., of the Dudley observatory, gave a brief account of his observations, beginning Sept. 29, and followed during October and November by a series of twenty complete comparisons with stars, the accurate places of which are to be obtained by the meridian circle of the observatory. Positions of the comet depending upon star places from catalogues of old observations have been, however, used for orbit work; five made here having been telegraphed by request to the Cambridge observatory and used for the 'normal place orbit,' the best that has appeared. Mr. Tucker showed the similarity of the elements of this orbit to those of others, notably those of 1843 and 1880. The best theoretic orbits, however, show that this cannot be a comet of short period, and consequently not a return of either of those above referred to. He also gave the results of measurements of the head and tail made at the observatory, and described the changes noted in the structure of the former; also some of the results of spectroscopic work elsewhere, showing, among other things, distinct sodium bands in the spectrum.

In answer to questions raised in the discussion, Mr. Tucker gave the perihelion distance of the comet as probably within 500,000 miles; and stated that the form of the orbit is probably an ellipse, but very nearly a parabola; also, that the comet is evidently to a great degree self-luminous; and, further, that the comet's motion was not affected by its near approach to the sun, — unless, perhaps, retarded by a solar atmosphere, — for the obvious reason that both the comet's motion and the form of its orbit were originally due to the sun's attraction. — (*Albany inst.; meeting* Jan. 30.) [260

## ENGINEERING.

**Transverse strength of wooden beams.** — Prof. Gaetano Lanza, of the Massachusetts institute of technology, described the testing-machine, and exhibited its mode of operation by breaking a 6×12 inch spruce beam, eighteen feet span, loaded at the middle. He also reviewed the results of some of his tests, as published in the Journal of the Franklin institute for February, 1883, and deduced a modulus of rupture of from 3,000 to 4,000 pounds per square inch in case of spruce, depending on the quality of the lumber; also, an average modulus of elasticity of 1,293,732. The results of four tests of *yellow pine* were also given with a time test on a 4×12 inch yellow pine beam, twenty feet long and loaded at the middle; also, the author's deductions from this time test as to the value of the factor of safety to be employed until a large number of tests shall determine the true value of the modulus of elasticity. — (*Bost. soc. civ. eng.; meeting* Jan. 21.) [261

## CHEMISTRY.

**Complex inorganic acids.** — Professor Gibbs stated, that, in the further generalization of the results of his investigation of the complex inorganic acids, he had obtained glycero-phospho-tungstate and glycero-phospho-molybdate of barium as well-defined and beautifully crystalline salts; also dimethyl-arsino-tungstate and dimethyl-arsino-molybdate of sodium in colorless, very slightly soluble crystals. He directed attention to the fact that hypo-phospho-molybdate of ammonium, which he had at first expressed empirically as, —

$$24\,MoO_3 . 6\,PO_2 . 6\,(NH_4)_2O + 7\,aq, —$$

should be written rationally, with 2 additional molecules of hydrogen, either as —

$$8\,MoO_3 . 2\,\{H_2 . PO . OH\}\,2\,(NH_4)_2O + 2\,aq;$$

or as —

$$8\,MoO_3\,2\,\{H_2 . PO . (ONH_4)\} . (NH_4)_2O + 3\,aq.$$

In like manner the phosphoroso-molybdate of ammonium described by him with the empirical formula, —

$$24\,MoO_3 . 2\,P_2O_3 . 5\,(NH_4)_2O + 20\,aq, —$$

should be written either —

$$24\,MoO_3 . 4\,\{H . PO . (OH)_2\}\,5\,(NH_4)_2O + 14\,aq;$$

or —

$$24\,MoO_3 . 4\,\{H . PO . (ONH_4)_2\}\,(NH_4)_2O + 18\,aq;$$

though of course in each case a partial replacement of $(OH)$ by $(ONH_4)$ within the molecule of $2\,\{H_2 . PO . OH\}$ or $4\,\{H . PO . (OH)_2\}$ is equally possible. The hypo-phospho-molybdates should be called *di-hydryl-phosphino-molybdates*, and the phosphoroso-molybdates *hydryl-phosphino-molybdates*. The dimethyl-arsino-tungstates and dimethyl-arsino-molybdates evidently belong to the first series. Prof. Gibbs further stated, that he had found that other modifications of phosphoric acid were capable of forming complex acids with tungstic and molybdic oxides, and that he had obtained very well characterized pyro-phospho-tungstates and meta-phospho-tungstates, as well as the corresponding molybdenum compounds. The molybdico-tungstates, the discovery of which he had announced at the last meeting of the club, and which contained molybdic dioxide ($MoO_2$), formed a particularly well defined and beautifully crystallized series. In conclusion, he described in detail the very remarkable relations of vanadic pentoxide ($V_2O_5$) to phosphoric and arsenic pentoxides, and gave an account of the phospho-vanadates and arsenio-vanadates considered as complex acids of an entirely new class. — (*Harvard chem. club; meeting* Jan. 23.) [262

## AGRICULTURE.

**A new nitrate ferment.** — The reduction, as well as the formation, of nitrates in the soil is now proved to take place under the influence of living organisms. A year and a half ago, while experimenting with infusions of the roots of plants in water, Dr. A. Springer noticed a copious evolution of nitric oxide proceeding from those rich in nitrates; this seemed to arise from the action of small organisms upon the roots. He then made separate infusions of the roots, stems, and leaves of tobacco, and divided each set into four parts. Fermentation was excited in these by yeast, by urine, by the 'spontaneous method,' and by the newly discovered ferment. Among the ferments developed was one which appears to have the property of dissociating the nitrates of the soil. This may be classed among the Anaerobies, but oxygen does not stun it. The ferment obtained from chalk by Bechamp (Bull. soc. chim. [2] vi, 484) is probably the same. Further experiments are in progress. — (*Ohio mech. inst.; sect. chem. phys.; meeting* Jan. 18.) [263

**Manuring vineyards.** — In experiments in three Rhenish vineyards, Wagner finds that manuring with soluble phosphoric acid (100 kg. per hectare) produced in one case no increase, in another case a considerable and profitable increase, and in the third case an undeniable decrease, of the crop. Addition of potash and nitrogen produced no, or only a very slight, increase. The soil was already rich. No explanation of the unfavorable effect of the phosphoric acid was evident; but experiments on other plants by the same experimenter have shown that excess of phosphoric

acid, especially in a dry soil, may hasten the death of the organs of nutrition. — (*Landw. versuchs-stationen*, xxviii. 123.) H. P. A. [264

**Determination of humus in the soil.** — Loges finds that the results obtained by oxidation with chromic acid and absorption of the $CO_2$ are too low. From 64 to 96 per cent of the total amount of carbon was obtained, the remainder being incompletely oxidized, and escaping partly as volatile products. The loss on ignition was hardly sufficient for even an approximate estimate of the amount of organic matter present. — (*Landw. versuchs-stationen*, xxviii. 229.) H. P. A. [265

GEOLOGY.

**The formation of coal.** — This memoir by M. Gaston de Saporta, written in a clear, elegant, and really admirable style, reviews and eulogizes without critical observations the essential point of the theory of Grand'Eury, mentioned in two other places in this issue. The first part of the review is a historical record of the researches made on the formation of coal since the first author who tried to ascertain its nature and composition, or from Antoine Jussieu to Buffon in France; then to the Germans Blumenbach, Schlotheim, Sternberg especially, and after him to Brongniart, who in 1837 was the first to consider the origin of coal as related to that of peat. The author of the memoir sees in the lignite deposits of Fuveau, near the Bouches du Rhone, analogy of formation with that of the paleozoic coal-beds, as it has been exposed by Grand'Eury. — (*Rev. des deux mondes*, Dec. 1, 1882.) L. L. [266

METEOROLOGY.

**Indian meteorology.** — The studies of A. N. Pearson, the acting meteorological reporter for western India, of the meteorological conditions in 1881, confirm the results of previous observations, that there are abnormal movements of atmospheric pressure which affect a very wide area, and which are not simultaneous in all parts of that area, but travel from west to east. The barometric readings made at Zanzibar, when compared with those of the Bombay presidency, show the possibility of predicting the general nature of the seasons in western India some months beforehand; but there are irregularities in these abnormal movements, the cause of which must be discovered before the nature of the seasons can be foretold with certainty. These observations of Mr. Pearson are to be welcomed, since they are in the direction of a legitimate forecasting of the seasons on a scientific basis. — (*Brief sketch meteor. Bombay pres.*, 1881.) W. U. [267

ZOÖLOGY.

Protozoa.

**Preservation of Protozoa.** — Henri Blanc recommends preserving protozoa with a mixture of 100 pts. concentrated solution of picric acid, 2 pts. sulphuric acid, and 600 pts. distilled water, with one drop of 1% acetic acid for every five centimetres of the mixture. For coloring use 5 grms. of safran dissolved in 15 grms. absolute alcohol, which is allowed to stand for a few days, and then be filtered. — (*Zool. anz.*, vi. 22.) C. S. M. [268

**Criticism of Künstler's theory of Protozoa.** — Künstler, in a recent thesis, attempted to overthrow the cell-doctrine in its application to Protozoa, and reported a number of surprising discoveries. Bütschli criticises him severely, and maintains that one form which he described as new, under the name of Künckelia gyrans, is in reality a Cercaria and not a Protozoan: Bütschli suggests that so gross an error ought to invalidate the whole article. — (*Zool. anzeig.*, no. 128.) C. S. M. [269

**Interesting new ciliate infusorian.** — "Mr. F. W. Phillips describes a new genus and species (*Journ. Linn. soc., zoöl.*, xvi. 476.) under the name of Calyptotricha pleuronemoides, found attached to Myriophyllum. The animals are furnished with a remarkable transparent hyaline ovate lorica, opening teat-like at both ends, and a vibratory membranous hood or velum almost equal to the ventral length. The anterior end of the body is protrusible from the lorica. Their length is .001 inch; and the non-vibratile setose body-cilia are about two-thirds of this length, with shorter, stronger vibratile cilia at the entrance of the velum." — (*Journ. roy. micr. soc. Lond.*, ii. 799.) C. S. M. [270

**Merejkowsky's Suctociliata.** — Merejkowsky found in the gulf of Naples an infusorian having both cilia and suckers, and therefore intermediate between the Ciliata and Acineta. The animal, which is very common, resembles a Halteria: the anterior part of the body has a conical neck, around the base of which is a crown of three circles of seven or eight stiff cilia; the mouth is at the front of the neck, and is surrounded by four conically placed suckers, which cannot, however, be observed when the neck is retracted: hence they were overlooked by Cohn, who has given a superficial description of the animal under the name of Acarella siro. Merejkowsky regards this as a new type of great phylogenetic importance. — (*Comptes rend.*, xcv. 1232.) [271

Maupas criticises this publication. Stein had long ago described an intermediate type, Actiorobolus. Merejkowsky's species has been long known as Halteria pulex (Clap. Lach.), H. tennicollis (Fresenius). The supposed suckers have been figured by Claparède and Lachmann, and described besides by Fresenius; and there is no proof that they are homologous with the suckers of Acineta, but they are organs of attachment by which the animal anchors itself. Maupas reiterates his opinion, that the ancestral affinities of the Acinata are to be sought with the Heliozoa, rather than the Ciliata. — (*Comptes rend.*, xcv. 1381.) C. S. M. [272

**Theory of the conjugation of Infusoria.** — Bütschli criticises the assertions made by Balbiani, in his lectures as reported in the *Journal de micrographie*, concerning the reproduction of Infusoria. He gives brief summaries of Balbiani's views as advanced in 1861, and of his own. The brief and clear *résumés* render the article valuable for reference, but the author's purpose is to correct certain misrepresentations which Balbiani has permitted to appear in his lectures. — (*Zool. anz.*, vi. 10.) C. S. M. [273

VERTEBRATES.

**Localization of functions in the cerebral cortex.** — From the results of experiments on dogs, Bochfontaine concludes that Flourens was correct in ascribing vicarious functions to the cerebral convolutions. At one time electrical stimulation of a particular surface area *a* may, for example, be followed by secretion of the sub-maxillary gland or by some definite movement of a limb, while the same stimulus applied to other regions of the cerebral surface has no such consequences. In half an hour or forty-five minutes the region *a* will, however, cease to react to stimuli, while some other area *b*, previously inexcitable, becomes irritable, and its stimulation is followed by the same phenomena as previously the stimulation of *a*. The author suggests that the gray rind is itself not capable of electrical excitation, and that the

result is always due to direct stimulation of subjacent medullated nerve-fibres. A bundle of such fibres, all with the same peripheral connection, may subdivide in the brain, and end in three or four different regions of its surface: to this assumption he adds the further gratuitous one, that only one cerebral division of the nerve-fibre bundle is excitable at any one moment. — (*Arch. physiol. norm. path.* (3), i. 1883, 28.) H. N. M. [274

**Properties of saliva.** — Why has human saliva the power of saccharifying starch-paste, while that of many animals, even herbivorous as the horse, has not? Under the prevalence of atmospheric-germ theories, some have lately been inclined to believe that human saliva owes its power merely to the fact that it is a good medium for the development of amylolytic bacterial organisms. Béchamp, as a result of somewhat extended observations, concludes: 1°, that the starch-saccharifying activity of human saliva is not due to chance germs which have entered the mouth from the atmosphere; but 2°, is due to a special ferment more active than diastase; and 3°, produced by the action on the pure secreted saliva of specific microscopic organisms living in the salivary glands and in the mouth-cavity of man. The pure parotid saliva of horse or dog does not convert starch-paste into copper-oxide-reducing substances, nor does it acquire this power when exposed to the air, or when gently warmed along with scrapings from the tongues of those animals; but when scrapings from the inside of the human mouth are added to it, it soon becomes a very efficacious agent for the saccharification of starch. — (*Arch. physiol. norm. path.* (3), i. 1883, 47.) H. N. M. [275

### Fish.

**A new genus of Lepidopodinae.** — In 1878 Mr. F. E. Clarke described (*Trans. New Zeal. inst.*, v. 294) a new lepidopodine as Lepidopus elongatus. Mr. Clarke established the species for 'eight or ten examples, all taken at Hokitika, on the South Island of the New-Zealand group' (lat. S. 43°, long. E. 171°). Singularly enough the new species has turned up, almost at the antipodes, on the Great Bank of Newfoundland; a specimen having been obtained from the stomach of a halibut, caught at a depth of eighty fathoms. The species has been re-described by Goode and Bean, and referred to a peculiar genus with the name Benthodesmus elongatus. It differs from Lepidopus by the more slender body, more numerous dorsal spines, etc. — (*Proc. U. S. nat. mus.*, iv. 379.) T. G. [276

**Schedophilus medusophagus in Ireland.** — A specimen of this interesting fish, 9¼ inches long, was caught in August, 1878, in a salmon-net at Portrush, County Antrim, and has been recently described and figured by Dr. Günther. The illustration differs very much from those previously published, but bears internal evidence of being much more correct than the others. No remarks have been made by Dr. Günther as to the affinities of the species, and hence it is presumable that he still adheres to his classification of the fish in the family Coryphaenidae. It, however, is evidently a stromateid, and closely related to the rudder-fish (Lirus or Palinurichthys perciformis) of the United States, and like that species is a pelagic form which merely visits the coast. — (*Trans. zoöl. soc. London*, xi. 223, pl.) T. G. [277

**Delolepis, a new genus of Cryptacanthidae.** — The family of Cryptacanthidae has been long confined to a single genus of two species, or sub-species, peculiar to the New-England fauna, but has recently received a notable addition from the west coast of America. The new species has been detected at Port Wrangel, Alaska, as well as at Kingcombe Inlet, Brit. Col., and differs from the typical species by the development of small cycloid imbricated scales. It has been, therefore, distinguished by Dr. T. Bean as a special generic form, under the name Delolepis virgatus. — (*Proc. U.S. nat. mus.*, iv. 465.) T. G. [278

**The Anguilla Kieneri of Günther a Lycodes.** — Some years ago ichthyologists were startled by the announcement, from Dr. Günther, that 'the young of Anguilla Kieneri, a species hitherto known from the Mediterranean only,' had been found in the North Atlantic at a depth of a hundred and eighty fathoms; and the specimen in question, *inter alia*, was even adduced in evidence 'that fishes hitherto known from more southern latitudes occur in the north Atlantic at a moderate depth (of between eighty and two hundred fathoms).' The fish thus identified has been re-examined by Surgeon Francis Day, and proves to have ventral fins, and not to belong to the same order as the A. Kieneri: it is, in fact, a species of Lycodes, a characteristic type of the northern waters of moderate depths. — (*Proc. zoöl. soc. Lond.*, 1882, 536.) T. G. [279

### Birds.

**Albinos.** — Mr. Charles A. Townsend called attention to a large number of albino specimens from the ornithological collection of the academy, among which the magpie and merganser had not, as far as he was aware, been before observed in this condition. The collection also included a kingbird, red-tailed hawk, chewink, and red-head duck, all of rare occurrence in the albino state. Melanism had only been observed by him in one specimen of a meadow-lark. — (*Acad. nat. sc. Philad.; meeting* Feb. 13.) [280

## ANTHROPOLOGY.

**Laughter in lower animals.** — In a discussion upon specimens of the orang and chimpanzee, M. Dally remarks that young negroes are gay and frolicsome, but no one has ever seen a negro aged over thirty or forty years show gayety, — in which respect there is a strong resemblance between them and the anthropoids, the latter being frolicsome in youth and morose when adult. This statement is startling to persons familiar with the negroes in America, who at all ages are noticeably light-hearted and merry. Nothing is more common here than the broad grin and loud laughter of a white-headed and coal-black negro. Indeed, the contrast between the inveterate and irrational merriment of the blacks, and the prevailing anxious, if not sad, expression of our adult white population, would present an argument regarding their relative inferiority in precise opposition to that urged by M. Dally. — (*Bull. soc. anthrop. Paris*, April–July, 1882.) J. W. P. [281

**Hero myths.** — Dr. Daniel G. Brinton presents another volume entitled "American hero-worship: a study in the native religions of the western continent." In it he discusses certain myths of the Algonkian, Iroquoisian, Aztekan, Mayan, andother linguistic families of North America.

The purpose of this volume is, "to show that their chief god was not identified with any objective natural process, but was humane in nature, benignant in character, loved rather than feared, and that his worship carried with it the germs of the development of benevolent emotions and sound ethical principles." This he attempts to do by giving interpretations of the myths in question. The gods are considered as anthropomorphic heroes of light and darkness, and the cardinal points of the compass.

The work is rather an elaborate study of some well-known but badly recorded myths. The myths discovered among savage and barbaric peoples, and told by untrained anthropologists, have as little value for the science of anthropology as the stories told by unscientific travellers concerning wonderful animals have for zoölogy. In every Indian village of North America, civilized or uncivilized, the myths of the ancient days are yet told; and the science of North-American mythology cannot be given to the world until thousands of myths now current are collected by trained men. — J. W. P. [282

**Mortuary customs.** — Several curious survivals in different departments of France noted; among them, beehives put in mourning with black cloth, on the death of the proprietor, to prevent flight of the bees after the soul. — (*Bull. soc. anthrop. Paris*, April–July, 1882.) J. W. P. [283

**Cranial deformation.** — In the collection of crania by M. Marche, from the Philippine islands, a large proportion exhibited an occipito-frontal compression, described by M. Topinard to be nearly identical with the results of the cranial compression of the Peruvians and Chinooks. — (*Bull. soc. anthrop. Paris*, April–July, 1882.) J. W. P. [284

**Brain-weight tables from Cochin China.** — A contribution of M. Neïs is described by M. Topinard as the most important yet received regarding the cranial capacity of the 'yellow race,' showing a near approach to Europeans, and marked separation from negroes, in this respect. — (*Bull. soc. anthrop. Paris*, April–July, 1882.) J. W. P. [285

**The nur-aghes of Sardinia.** — Dr. d'Hercourt described the ancient stone-works, or nur-aghes, of Sardinia, and contended that the object of their construction was for places of refuge for man and beast against sudden attack, and also to serve as signal-stations. — (*Bull. soc. anthrop. Paris*, April–July, 1882.) J. W. P. [286

**Races in Cochin China.** — M. de Claubry presents the characteristics of the Malabars, Malays, Cambodians, Chinese, and Anamites, the last named being the most interesting. — (*Bull. soc. anthrop. Paris*, April–July, 1882.) J. W. P. [287

---

## *INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.*

### GOVERNMENT ORGANIZATIONS.

#### Bureau of weights and measures.

*Distribution of standards.* — Under the provisions of a joint resolution of the two houses of congress, approved March 3, 1881, there are now preparing in the Bureau of weights and measures, at Washington, sets of customary English standards, for distribution to the governors of the various states, for the use of the agricultural colleges throughout the country. One set is to be sent to each state. In cases where there are two or more agricultural colleges in one state, the question of assignment is left with the governor. Each set consists of a yard-scale divided to tenths of inches; weights, twenty-six in number, ranging from twenty-five pounds to one grain; liquid measures from a gallon to a pint; and dry measures from a half-bushel to a quart. These are closely adjusted to the standards, and with each set will be sent a table of the very small residual errors shown to exist by the final comparisons. The adjustment of these weights and measures is now so nearly completed that notifications have been sent to the governors of most of the states, and the distribution will begin in a few weeks. These standards will serve an important use in educating students to ideas of accuracy in this most important matter. The general government has already supplied to each of the states, for use as state standards, full sets of English weights and measures, and also balances. Upon the passage in July, 1866, of the act legalizing the metric system in the United States, the general government also furnished to each state complete sets of metric weights and measures. These sets are kept at the respective seats of government, and are available for the verification of the standards used by the county or town sealers of weights and measures. Being all carefully adjusted to a common standard, their use will procure practical uniformity in weights and measures throughout the country.

#### Geological survey.

*Topographical work.* — Congress having authorized the extension of the work of the geological survey into the older states, topographical work, preparatory to geological study, was commenced in the southern Appalachian region shortly after the adjournment of congress last August. A division, consisting of one party for carrying on triangulation, and three for topography, was organized at Bristol, Tenn. Triangulation was extended north-west-ward from the Coast Survey belt along the Blue Ridge, the line 'Benn Knob to Poore's Knob,' as determined by the Coast and geodetic survey, serving as a base. About 5,000 □ miles only were surveyed, as the season for field-work was short, and the weather very unpropitious. The area surveyed includes portions of the high mountain region of east Tennessee, western North Carolina, south-western Virginia, and eastern Kentucky.

For the purpose of testing thoroughly the practical value of Mr. G. K. Gilbert's method of reducing barometric observations, four barometric stations were established about and on the summit of Roan Mt., N.C., at elevations ranging from 2,000 to 6,300 feet, and connected with one another by level lines.

Besides the work of this division, geographic work was carried on in northern California, looking towards mapping the Cascade range, with a view of studying its volcanic phenomena.

Another geographic division continued the work in western New Mexico, commenced the previous year; while a fourth division commenced work in southern Montana, near Bozeman.

Besides these four divisions engaged upon general geographic work, a number of parties were engaged upon special and more detailed surveys. Among these surveys may be mentioned that of the quicksilver mining-districts of California, of the Silver cliff and other mining-districts of Colorado, and the surveys for tracing out the shore-lines of the fossil lakes of western Nevada and Oregon.

#### National museum.

*Telegraphic announcement of the stranding of large marine animals.* — A short time ago the men at the different life-saving stations along the entire coast were instructed by Supt. Kimball to telegraph to Washington the stranding of any large marine ani-

mal, immediately upon its occurrence. The first fruit of this excellent system, in the form of a highly interesting shark, arrived at the Smithsonian Institution on the 14th inst., from Amagansett, Long Island. To indicate the importance which this new departure seems likely at once to assume, it may be stated that this first specimen, having been examined by Dr. T. H. Bean, curator of the department of fishes, proves to be a species of Pseudotriacis, a genus of which no representative has been hitherto recorded as occurring in the western Atlantic. The species, P. microdon, to which the Amagansett shark belongs, was made known in 1867, by Capello, from the coast of Portugal.

### Bureau of Ethnology.

*Cliff dwellings in the Cañon de Chilly.* — The ethnologic and archeologic researches that were begun a few years ago in the north-west were continued during the present season in that region known as the San Juan, principally in the cañons formed by the drainage of that river and its tributaries. The examinations of ruins were conducted in Cañon de Chilly and some of its principal side cañons, by Col. James Stevenson; and some important and interesting discoveries and collections were made. About forty-five ruined villages and dwellings were visited, many of which were carefully explored. Several of the more important villages were surveyed, and careful measurements taken, from which to construct models. About one-fourth of the number of ruins observed in these cañons were situated so high up in the sides of the cliff walls as to be inaccessible. Those, however, from which the finest specimens were obtained, and which presented the most novel features of architecture, were reached. One village, in this connection, is worthy of special mention. It is located in a side cañon of the de Chilly, about twelve miles from its junction with the main valley. The ruins occupy a space of about 900 feet in length by an average width of 125 feet. It is located in a large cave-like opening, whose arch circles over the village to a height of about 200 feet. Some of the houses have tumbled completely down; others are in a partial state of preservation; and a few are so well preserved as to present the whole plan of architectural design, as well as all the details of the masonry. This dwelling showed, that, wherever implements were used in its construction, they were made of stone; and no evidence appeared that the inhabitants had any knowledge of metal. The implements were all either of bone, stone, or wood.

At intervals among the ruins stood the walls of four estufas, in a sufficient state of preservation to enable one to define very closely the character of the original structure. These were circular, but varied quite essentially from estufas of the present day. The interior of one of these has a wide band, laid on in bright, durable colors, running entirely around the structure, resembling a Greek fret, with narrow bands above and below, and with the interior spaces filled with curious artistic designs. The walls in the rear of the ruins are literally covered with picture-writing, and in every convenient spot may be seen small cup-like cavities produced by sharpening stone implements.

In front of the village was found a burial cist, or artificially constructed oven-shaped pen, in which were found the remains of four human skeletons. The manner and care manifested in the burial of these dead may be taken as a type of the burial-customs of the cliff-dwellers. This cist, or oven, was composed of small logs, stones, and plaster. The diameter of the urn at the bottom is about four feet, closing toward the top in the shape of a dome. The logs were laid one on the top of the other, earth thrown up around the outside, and the interior heavily coated with plaster. The skeletons were doubled up like mummies, though buried without being wrapped in cloth or clothing of any kind. These skeletons were secured, and brought to the National museum. Among the *débris* of these same ruins were found many objects of dress and clothing, several kinds of moccasons or sandals, showing fine workmanship and skill in weaving, and many other objects illustrative of the art, manners, and customs of the cliff-dwellers; a full account of which will appear in Major Powell's official report from the bureau.

## PUBLIC AND PRIVATE INSTITUTIONS.

### Harvard college observatory.

*Transmission of astronomical intelligence.* — An association of about fifty European observatories has recently been formed for this purpose, with its headquarters at the Royal observatory, Kiel, Germany, directed by Prof. Krueger, who has taken charge of the business of the association. Connections by cable have been established with South America, South Africa, and Australia; and the observatory has been requested to co-operate with it, in the United States, by receiving and distributing in this country the telegraphic information sent from Kiel, and by forwarding to Kiel by telegraph any similiar information of importance collected from American astronomers. By the courtesy of Prof. Baird, secretary of the Smithsonian institution, the function hitherto performed by the institution, of collecting and transmitting announcements of discovery, has been transferred to the Harvard college observatory.

The importance of the work thus begun requires that a special officer of the observatory should be intrusted with it. Mr. John Ritchie, jun., has accordingly been appointed assistant in charge of this service, and the details of the proposed system are explained by him in a circular, which may be had on application.

American astronomers are requested to send to the "Harvard college observatory, Cambridge, Massachusetts," telegraphic information of discoveries of comets, asteroids, or phenomena of any kind requiring immediate attention. Arrangements will be made to refund the cost of such telegrams to the senders when their contents are of importance. It is very desirable that the messages should conform to the principles stated in Mr. Ritchie's circular.

It is intended that the distribution of information in this country shall be of such nature as to be productive of the greatest possible benefit, and will be of the broadest possible character. Discoveries, whether by American astronomers or by foreigners, will be circulated through the associated news companies, by special circulars of the Science observer, and by special telegrams.

---

## NOTES AND NEWS.

— The National academy of sciences at its last meeting appointed a committee, of which Prof. C. A. Young is chairman, and Prof. J. H. C. Coffin secretary, to arrange plans for observing the total eclipse of the sun of May 6 next. This eclipse is of unusual importance, as the duration of totality at its maximum value is 5 m. 55 sec. Unfortunately, the path of the shadow lies wholly in the Pacific Ocean, and

there are only a few small islands from which observations are possible. Mr. C. H. Rockwell, at the recent meeting of the American association, suggested the feasibility of sending an expedition to Caroline Island, which is situated in latitude 10° south, and longitude 150° west; and his plan has been adopted by the committee. A small appropriation of $5,000 was asked from Congress to defray the necessary expenses, and forms one of the items in the sundry civil bill now under consideration, with little doubt of its being granted.

The expedition leaves New York to-day by steamer for Callao, *via* Panama. At this point, through the courtesy of the secretary of the navy, a man-of-war receives the party, and conveys them to Caroline Island. This is a small coral island, and said to be inhabited by a few persons. It is near the central line, and will give the observers a period of about five minutes, or a few seconds more, of the total phase.

The members of the party are as follows: Prof. E. S. Holden of Madison, Wis.; Mr. C. H. Rockwell of Tarrytown, N.Y.; Prof. C. S. Hastings of Baltimore; Mr. E. D. Preston, U. S. coast-survey; Mr. W. Upton, U. S. signal-office; and Ensign Brown, U. S. navy. The party will be further increased by two English astronomers sent by the Royal society, who will join the expedition at Panama.

The most important observations planned are a search for intra-mercurial planets, spectroscopic observations, and photographic work. The last named is wholly in the hands of the English guests of the party. Professor Hastings has planned the spectroscopic work, and will use a 6¼-inch, a 4$\frac{1}{10}$-inch, and a 2¼-inch telescope. The first named is fitted with a grating for examination of the chromosphere before and after totality, and with a large prism for special study during the total phase of the outer corona. The second is provided with a grating, and also a single prism, and is designed for use in studying the relative lengths of lines reversed just before totality, and the limits to which the line 1474 K can be traced. The smallest instrument has a 30° prism of flint-glass placed before its objective, and is designed for observing the relative heights and brightness of the rings $H_\alpha$, $H_\beta$, $H_\gamma$, $H_\delta$, $D_3$, and 1474 K.

The instrumental outfit includes, in addition, a 6-inch telescope, a 4-inch and a 2¼-inch polariscopic apparatus, and meteorological instruments for studying radiation and other phenomena.

It is probable that the expedition will arrive at Caroline Island the latter part of April. After the eclipse the naval vessel will sail for Honolulu, from which the party will return *via* San Francisco. The Coast-survey observer carries a pendulum, which will be swung at various points as occasion offers. The chances of fair weather are very good, and the outlook for the success of the expedition seems in every way to be favorable. It is not known that any other expedition will be sent to observe the eclipse; though a French expedition to observe at Flint Island, which is near Caroline Island, has been planned.

— The American members of the International congress of electricians, which assembled in Paris in 1881, were: Hon. Levi P. Morton (American minister), Prof. G. F. Barker of Philadelphia, Major D. P. Heap, U.S.A., Dr. Cornelius Herz, Lieut. T. C. Maclean, U.S.N., and Prof. Henry A. Rowland of Baltimore.

The members chosen by the U. S. government to represent them at the Electrical conference, held in October, 1882, — of which an account is given in our leading article, — were Prof. Henry A. Rowland of Baltimore, and Prof. John Trowbridge of Cambridge.

— Not a few of our younger scientific men will feel a personal loss in the recent death of Hon. Paul A. Chadbourne, president of the Massachusetts agricultural college. Previously president of the University of Wisconsin and of Williams college, earlier professor at the latter institution and at Bowdoin college, an instructor in chemistry, materia medica, geology, botany, zoölogy, and natural theology, he has been brought all his life into contact with young men, and has impressed them with his earnestness. Occupied in too many and too varied pursuits to give his strength to research, but possessed of native powers and intuitive perceptions which would have enabled him to accomplish much in such a field, he has yet encouraged so many young men in the beginning of their career, — men who to-day hold their own in American science, — that his name deserves honorable mention here. He was a man of intense activity and diversified talents; being perhaps equally known as preacher, legislator, lecturer, and manufacturer, but best of all as an instructor. He died in his sixtieth year.

— A course of seven free Saturday-night lectures at the Cooper Union, New York, commencing Feb. 17, is announced as follows: Miss L. Von Finkelstein, on Domestic and city life in Jerusalem; Rev. J. C. Eccleston, D.D., on Columbus and his companions; Dr. Samuel Kneeland, on the Sandwich Islands, the land of fire; the same lecturer, on Iceland, the land of desolation; Prof. H. L. Fairchild, on Animal self-defence; the same lecturer, on Prehistoric man; the last of the course by J. H. Wilson, Esq., on Spain. All the lectures will be illustrated.

— At a meeting of the American philosophical society held at Philadelphia on Feb. 21, the subject of glacial motion was treated by Professors Lewis, Frazer, and Lesley; Prof. Lewis discussing the various causes assigned for the extension and southward flow of the great glacier, Prof. Frazer recounting the observations of Messrs. Peach and Horne on the glaciation of Scotland, and Prof. Lesley giving an amusing description of the rival theories of British glaciation urged by different geologists.

— Prof. C. S. Sargent of Harvard university has in preparation a new North-American Sylva. The drawings will be made by Mr. Charles E. Faxon, and the work will be published by the U. S. government.

— The latest numbers of the zeitschrift of the Berlin Gesellschaft für erdkunde (h. 4 and 5, xvii. 1882) contain papers on Russian surveys in 1881, by Lademann; Haussknecht's travels in Asia Minor and Persia, by H. Kiepert; on some Branches of the Amazon, translated from the Portuguese by W. Reiss, with a map showing the great irregularity of the channel between long. 55° and 60° W. Gr., and its frequent expansion into lakes.

— One of the tables at the zoölogical station at Naples is occupied the present season, by appointment of the University of Cambridge, Engl., by an American, Miss Emily A. Nunn, formerly professor of biology at Wellesley college, Wellesley, Mass.

— The Boletim da sociedade de geographia de Lisboa, 1882, No. 5, contains continued articles on the Portuguese possessions in eastern Africa, translated from O'Neill's observations, on Portuguese colonies (No. xx., in Belgium), and on the island of St. Nicholas (Cape Verde); and the results of meteorological observations in Loanda, 1879-81, by Coelho, from which we note the following factors. The barometric pressure (at an altitude of 59 met.) has its maximum of 759 mm. in July or August, and minimum 755 in January or February; the daily variation is 2.7 mm. The temperature averages 23° C., varying from 19° in July or August to 25° or 26° in February, with an average daily range of from four to eight degrees; the absolute maximum is 31°.7, and absolute minimum, 13°.5. The relative humidity averages 82, and rarely falls below 70. The west wind is much more frequent than any other, and seems to bring two seasons of rain, one about December, and a greater one about April; but in the three years of observation the results are very variable, 1879 giving a total rain of 571 mm., and 1881 having only 134. From May to October inclusive, very little rain falls; and June, July, and August are practically rainless. Evaporation carries off about 1.9 met. of water a year, and cloudiness averages five in a maximum of ten.

— During the last tourist-season in the Alps, fourteen persons were injured in mountain-climbing, three of them fatally. Bohren of Grindelwald was struck by lightning on the Wetterhorn, and instantly killed. Notary v. Hütte of Bern, in attempting an ascent of the Wilde Frau, had lowered a companion by a rope over a steep wall some fifteen feet high; but was severely hurt in jumping after him, and died from his injuries. A son of Surgeon Wahli of Bern fell on the Niesen, while picking *alpenrosen*, and was dead when found.

— In October of last year, a society was organized in Ottawa, Canada, called the 'Ottawa microscopical society,' with J. F. Whiteaves, Esq., F. G. S., as president, and J. B. Tyrrell, B.A., as secretary and treasurer. During the winter papers have been read and illustrated on the following subjects: Deep-sea soundings; Microscopic structure of rocks; Some insect parasites; Diatoms; and Human cellular tissue. The summer will be given to collecting, and next winter the society hopes to have a large amount of material for study.

— An ingenious device for stirring up sluggish fish, as a preliminary to catching them through the ice, is mentioned by Lansdell in his recent book of travels, *Through Siberia*, as being employed by the natives on the river Irtish. The process is there specially applied to the capture of sturgeon, which in winter congregate in muddy hollows in the bed of the river, where they lie motionless for the sake of the warmth. The fishermen cut holes in the ice, and set spring-lines at them, and then proceed to heat a number of balls of clay red hot, and to throw them into the river below the bait. The heat rouses the fish, which rise, swim up the stream, and are caught. It would be of interest to determine by experiment whether any of our own food-fishes could be induced to take bait by inciting them to activity by means of heated bricks.

— The Acadian science club has been formed in Nova Scotia for the encouragement of home study. The 'Acadian scientist,' published at Wolfville, N.S., is its official organ.

— There seems to be a common impression that the nickel five-cent piece was intended to weigh five grammes and to measure two centimetres. The coinage of 5-cent nickel coins (nickel and copper alloy) was authorized by an act of Congress May 16, 1866, and was begun during that fiscal year. The act left the shape and devices upon the coin to the discretion of the director of the mint, subject to the approval of the secretary of the treasury. The weight of the coin was fixed at 67.16 grains, or 4,352 milligrammes, with a margin of 2 grains or 125 milligrammes each way to allow for accidents of coinage. Three five-cent nickels of the date 1866 were found to weigh 4.828, 4.869, and 4.920 grammes respectively. Two of the date 1872 weighed 4.906 and 4.982. Seven coins of different dates measured twenty *and one-half* millimetres within one-tenth of one millimetre.

Evidently there was no intention to make the coin two centimetres in diameter, nor to have it weigh either four grammes or five. It may be remarked that all the coins are above the legal limit of weight (4.48 grammes).

— The National convention of agriculturists held at the U. S. department of agriculture the last week of January called together delegates from nearly every state in the union. The first and second sessions (Jan. 23 and 24) were devoted to a discussion of

agricultural colleges and societies, and of the general subject of agricultural education. Papers were read by Dr. O. C. Abbott of Michigan, Mr. Augustine Smith, Hon. Jno. A. King, Prof. J. A. Holmes of North Carolina, and Hon. D. W. Aiken of South Carolina.

Animal industries were discussed on Jan. 25, 26, and 27; and papers were presented by Mr. R. Baker of Ohio, Dr. James Law of New York, Mr. R. V. Gaines of Virginia, Mr. T. D. Curtis of New York, Mr. H. B. Guiler of Illinois, Mr. Ezra Stetson of Illinois, Prof. Wesley Webb of Delaware, and Dr. M. G. Ellzey of Virginia. Much interest was manifested in both of these sessions, and the general discussions were animated and interesting. On the 29th, the last day, and the one set apart for the consideration of the cotton industries, there was a decided falling-off in attendance; many of the delegates having left for home Saturday night, the 27th.

These conventions which Dr. Loring has called together, and which he inaugurated a year ago, have been productive of much good in bringing representative agriculturists into closer relations with the department. They indicate the desire of the commissioner to study the wishes and opinions of the people in the management of the department, and thus to increase its usefulness.

— Advices received from the U. S. consul at Montevideo, through the Department of state, show an alarming condition of affairs in parts of Uruguay from the ravages of destructive locusts. Foreign countries frequently apply through the state department for copies of the two reports of the U. S. entomological commission on the Rocky-Mountain locust; and it may be well to announce that they were published under the interior department, and are both out of print. The agricultural report for 1877 contains a condensed account of the more practical chapters by Professor Riley, and this may yet be obtained of the commissioner.

— The agricultural committee of the house has agreed to report favorably a bill introduced by Mr. Anderson of Kansas, which empowers the President to appoint nine commissioners whose duty it shall be to investigate thoroughly the movements of agricultural products from points of production to their final markets, the actual cost to the common carrier and his profits, and all matters which practically affect the difference between the prices received by the producer and those paid by the consumer.

— In Salusbury's translation (p. 79) of Dialogue first of Galileo on 'His Systeme of the World,' 1661, Sagredus is made to say, "You put me in mind of a man, who would have sold me a secret how to correspond, by means of a certain sympathy of magnetick needles, with one that should be two or three thousand miles distant; and I telling him, that I would willingly buy the same, but that I desired first to see the experiment thereof, and that it did suffice me to make it, I being in one chamber, and he in the next, he answered me that in so small a distance one could not so well perceive the operation; whereupon I turned him going, telling him that I had no mind at that time to take a journey unto Grand Cairo, or to Muscovy, but that if he would go himself, I would perform the other part, staying in Venice."

## *RECENT BOOKS AND PAMPHLETS.*

**Amateur** mechanics: an illustrated monthly magazine; conducted by Paul N. Hasluck. Part 1. London, *Trübner*, 1883. 32 pl. 8°.

**Amos**, S. The science of politics. London, *Paul*, 1883 (Intern. sc. series). 496 p. 8°.

**Bell**, Alexander Graham. Upon the electrical experiments to determine the location of the bullet in the body of the late President Garfield; and upon a successful form of induction balance for the painless detection of metallic masses in the human body. Wash., *Gibson pr.*, 1882. 58 p. 8°.

**Boase**, H. S. A few words on evolution and creation. London, *Leng*, 1883. 276 p. 8°.

**Buffalo** — Naturalist's field club. Bulletin. Vol. 1. nos. 1-2. Buffalo, *Hicks pr.*, 1883. 48 p. 8°.

**Campbell**, J. L. Geology and mineral resources of the James River valley, Va.; with map and geological sections. N.Y., *Putnam*, 1883. 119 p. 8°.

**Charmes**, Gabriel. Five months in Cairo and in Lower Egypt; transl. by W. Conn. London, *Bentley*, 1883. 356 p. 8°.

**Crowe**, A. H. Highways and byways in Japan: the experiences of two pedestrian tourists. London, *Low*, 1883. 318 p. 8°.

**Duncan**, J. Life of John Duncan, Scotch weaver and botanist; with sketches of his friends and notices of the times, by W. Jolly. London, *Paul*, 1883. 524 p., portr. 8°.

**Grierson**, J. B. Electric lighting by water-power. London, *Spons*, 1883. 8°.

**Hinrichs**, Gustavus. Notes on cloud forms and the climate of Iowa. Iowa City, 1883. (12) p. illustr., map. 8°.

**Hoar**, C. Mensuration made easy; or, the decimal system for the million. London, *Wilson*, 1883. 84 p. 8°.

**Jackson**, L. D'A. Hydraulic manual; consisting of working tables and explanatory text. Intended as a guide in hydraulic calculations and field operations. *4th ed.* London, *Lockwoods*, 1883. 496 p. 8°.

**Lackowitz**, W. Bilder aus dem vogelleben Norddeutschland und seiner nachbarländer, nach skizzen von Paul M. Röper bearb. 1. lief. Berlin, *Ebhardt*, 1883. 24 p. l. 8° (to be completed in 25 parts).

**Meigen**, W. Die deutschen pflanzennamen Wesel. *Kühler*, 1882. 27 p. 8°.

**Nature** studies. By Grant Allen, Andrew Wilson, Thomas Foster, Edward Clodd, and Richard A. Proctor. London, *Wyman*, 1883 (Knowl. libr.). 322 p. 8°.

**Nemontis**, W. S. Darwin's evolution theory not supported by evidence. London, *Sampson*, 1883. 23 p.

**Ohio** meteorological bureau. Report for October, November, December. 3 nos. n.p., 1882. 16, 24, 34 p. 8°. — Circular of information, 9 p.

**Perry**, J. Practical mechanics. London, *Cassell*, 1883. 270 p. illust. 12°.

**Proctor**, R. A. The stars in their seasons; an easy guide to a knowledge of the stars, exhibiting, in twelve large maps, the appearance of the heavens at any hour of the night, all the year round. London, *Wyman*, 1883. 8°.

**Rawlinson**, G. Antiquity of man, historically considered. London, *Rel. tract. soc.*, 1883. 44 p. 8°.

**Smith**, G. Assyrian discoveries; an account of explorations and discoveries on the site of Nineveh, during 1873 and 1874. *7th ed.* London, *Low*, 1883. 466 p. 8°.

**Smith**, G. The geography of British India, political and physical. London, *Murray*, 1883. 570 p., maps. 8°.

**Wilkinson**, H. Sunny lands and seas; a cruise around the world in the S. S. 'Ceylon.' London, *Murray*, 1883. 8°.

**Williams**, W. Matthieu. Science in short chapters. N.Y., *Funk & Wagnalls*, 1883. 308 p. 12°.

**Year-book** of pharmacy. 1882. London, *Churchill*, 1883. 607 p. 8°.